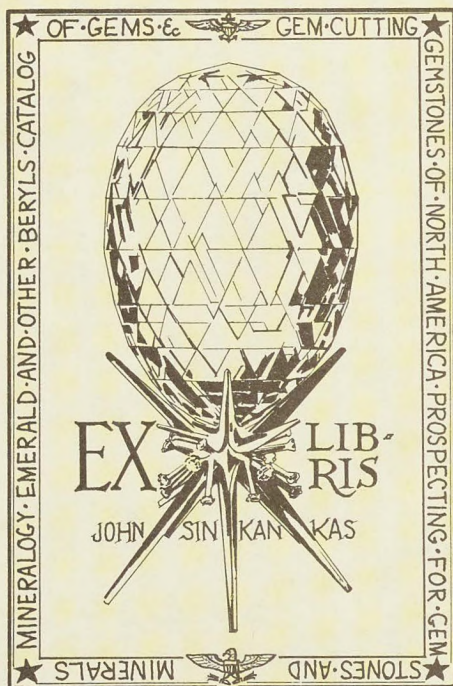
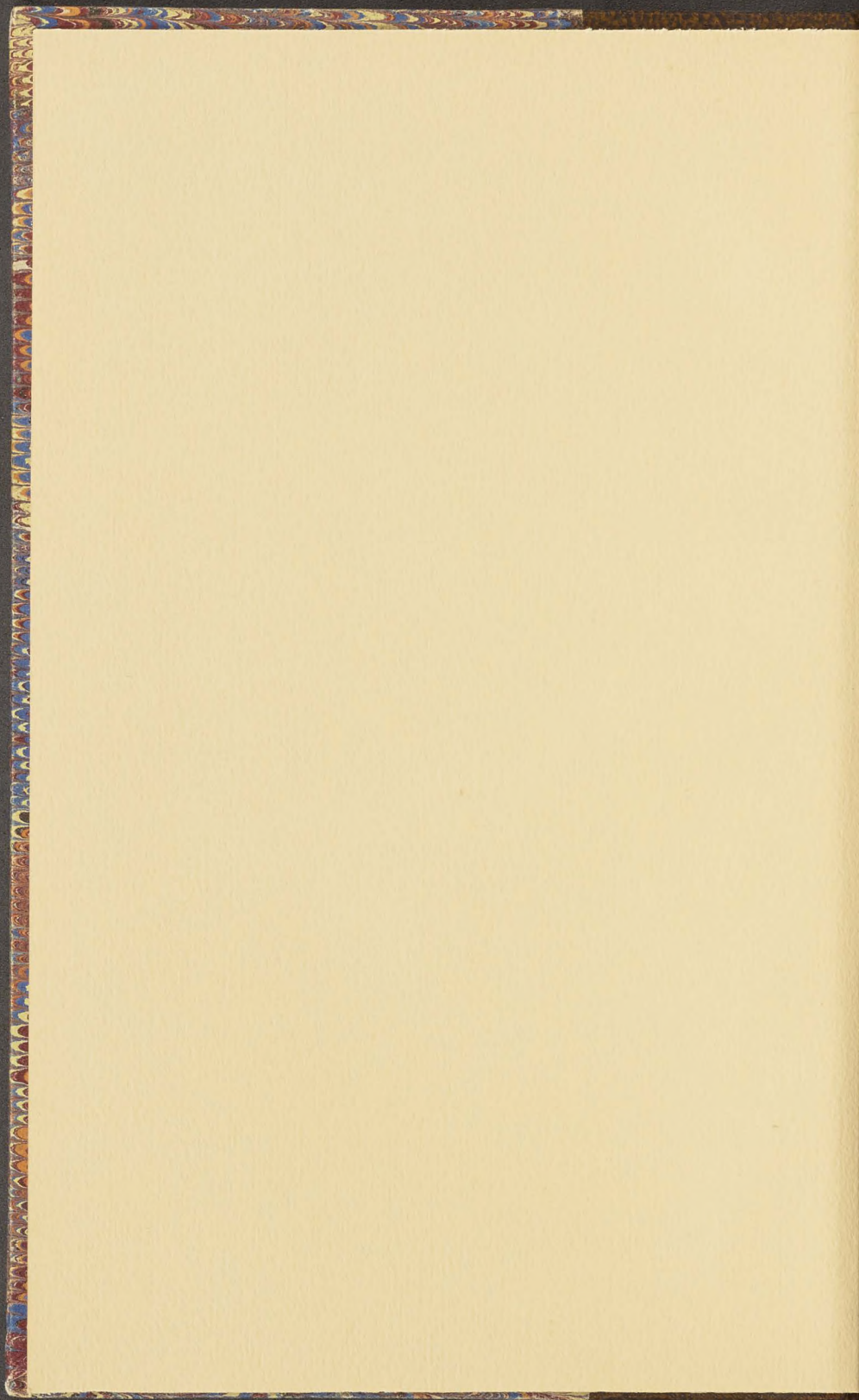


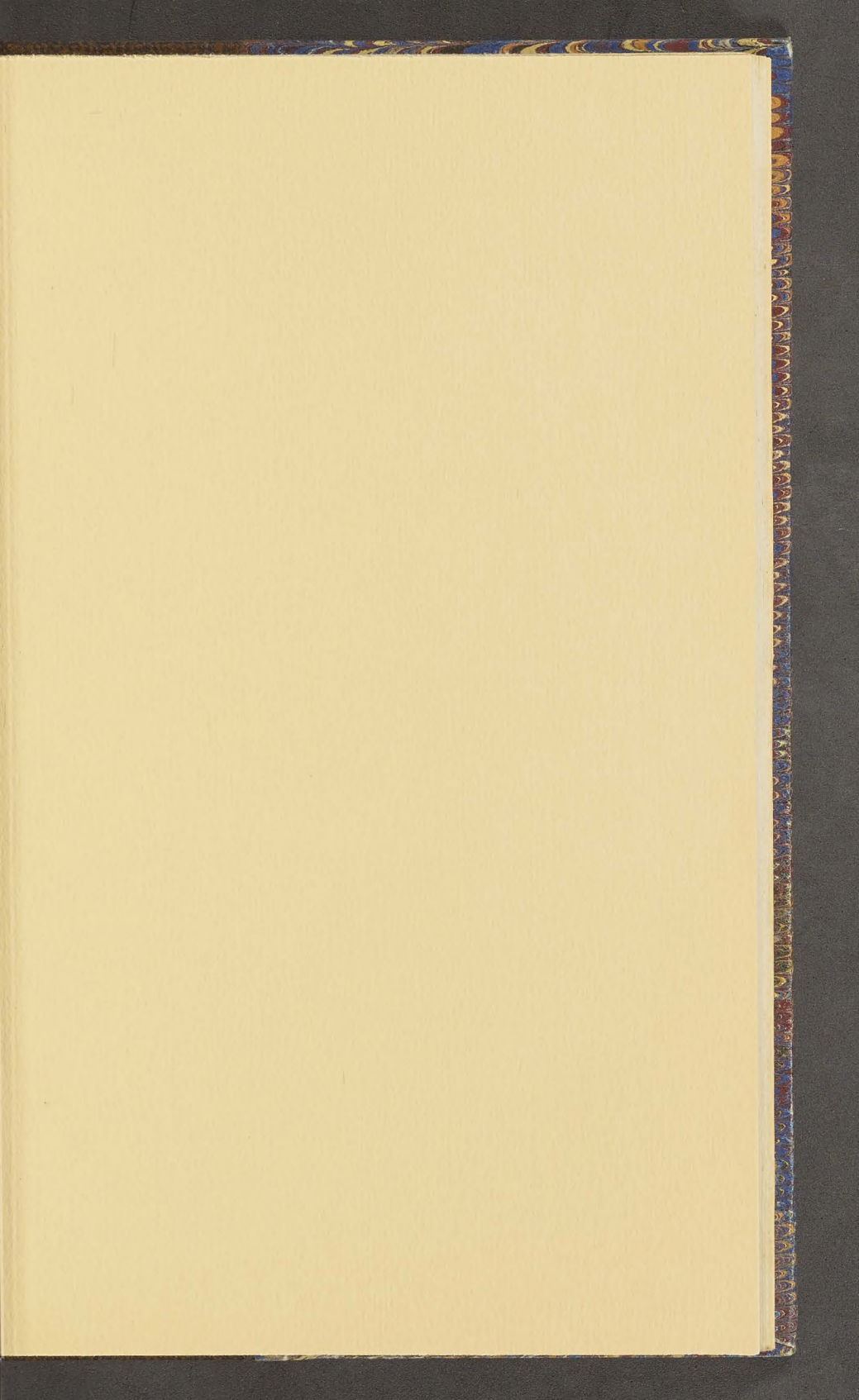
JS

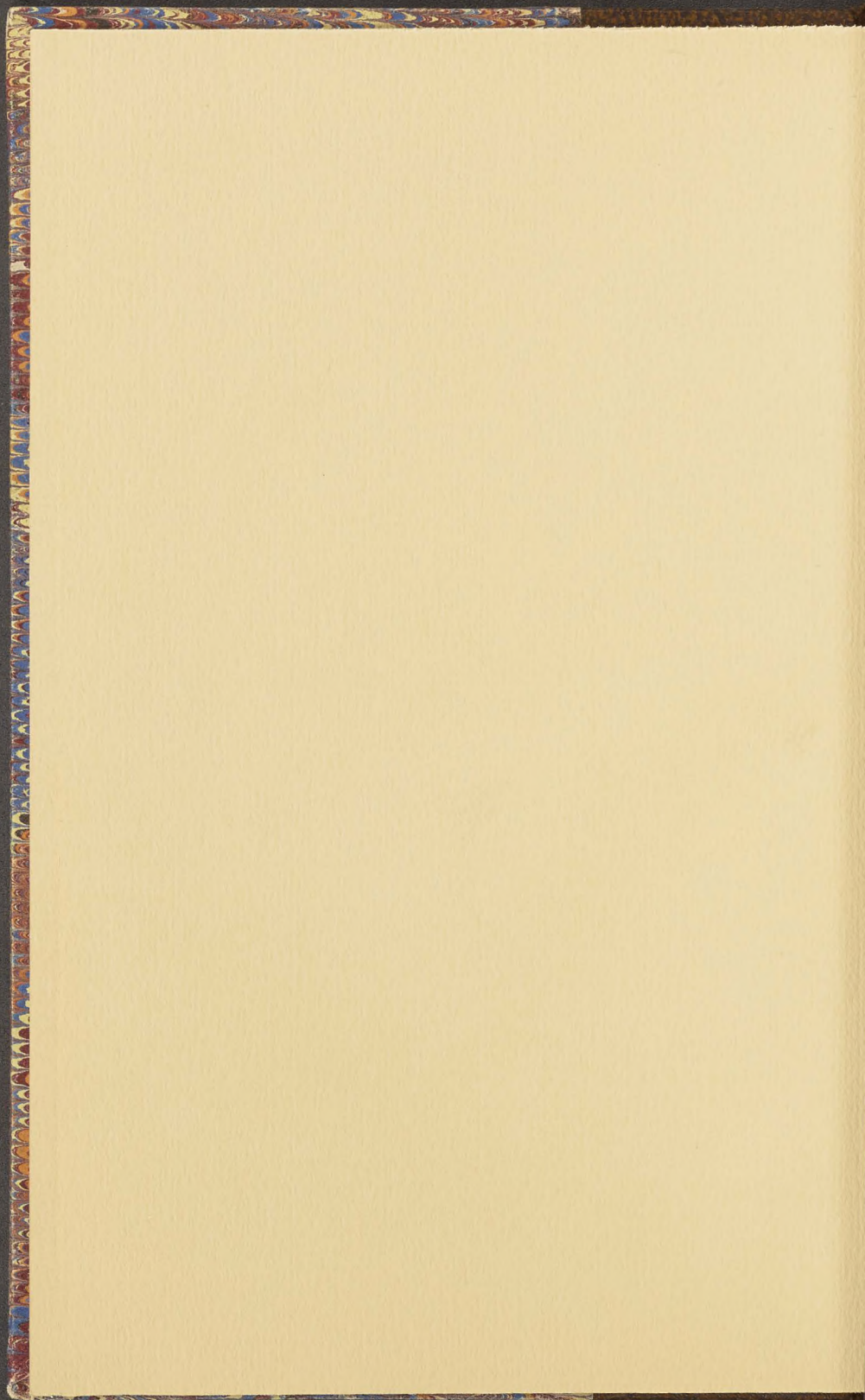
Cont
15th 11/2/81
PLG



Extracted from T. Bergman's Physical and Chemical
Essays, translated by Cullen, London, 1784, vol-
ume 3, pp. 205-316.







THOUGHTS

ON A

NATURAL SYSTEM

OF

F O S S I L S.

*Res ardua, vetustis novitatem dare, novis auctoritatem—dubiis
fidem, omnibus vero naturam et naturæ suæ omnia.*

PLINIUS.

PART I.

ARRANGEMENT OF FOSSILS.

NATURAL BODIES IN GENERAL.

§ I. *Principal Division of Natural Bodies.*

ALL bodies which nature spontaneously produces upon the surface of the earth may be properly divided into *organised* and *unorganised*.

§ II. *Organised*

§ II. *Organised Bodies.*

THESE are possessed of a number of internal vessels, by which, from the nourishment they take in, the particles necessary to the increase, support, and propagation of such bodies, are extracted, prepared, conveyed, and distributed.

§ III. *Classes of organised Bodies.*

THESE bodies are distinguished by the epithet *living*; and, whether they possess sensibility or not, they constitute two immense classes, the *animal* and the *vegetable*, which are commonly considered as two distinct kingdoms in nature.

§ IV. *Unorganised Bodies.*

THOSE bodies are termed unorganised that are entirely without any organic structure, and seem to be formed by the accumulation of particles united solely by the external force of attraction.

§ V. *Various*

§ V. *Various Consistencies of unorganised Bodies.*

THESE differ in many respects, but we shall here take notice of the degrees of *density* only, which has commonly been designed by the name of consistence.

§ VI. *Solid Bodies.*

CONSIDERING these, then, according to this rule, we find some bodies so *solid*, that their particles are so firmly united as not to be separated but by a very considerable force. Of this kind are most of the fossils.

§ VII. *Liquid Bodies.*

SOME again are *liquid*, whose component parts adhere so loosely, that they may be separated by the smallest impulse; but being left undisturbed, they, by the force of gravity, arrange themselves in such mutual equilibrium, as to present a surface parallel always to the horizon.

§ VIII. *Fluid*

§ VIII. *Fluid Bodies.*

OTHER bodies are reckoned *fluid*, whose particles are not only easily separable, but seem in some degree to repel each other. It is true, they seek an equilibrium; but, as they are not less influenced by elasticity than by gravity, they oftener appear with the unequal surfaces we daily see in clouds and vapours.

§ IX. *The Utility of this Distinction.*

ALTHOUGH the same body, as occasion requires, may undergo every variation of consistence, yet this distinction is not the less to be regarded; for peculiar qualities, with a considerable difference in their proportions belong to each condition. But the plan we have proposed to follow, will not admit of a further explanation of this matter.

§ X. *The continued Series of Natural Bodies.*

THE great Leibnitz, by that law to which he gave the name of *continuity*, denied formerly that there could possibly be any interruption
tween

tween physical causes and effects; and maintained, with such confidence, its invariable operation and influence, that he predicted, that some time or other a species of animals (as the zoophyta) would be discovered, partaking more or less of the nature of vegetables.—The celebrated Trembleyus, by the discovery of the Poly-pi, afterwards confirmed the truth of this preface. Daily experience also convinces us of the existence of such a connecting chain in the order of natural bodies; so that, though we are acquainted with several links singly, yet it may seem scarce possible to ascertain those that should be immediately united to them.

§ XI. *The Necessity of a System in Natural History.*

As natural bodies may in various ways be rendered useful to man, a thorough knowledge of them becomes highly necessary; and it will, indeed, in general be found, that their utility encreases in proportion to the extent of that knowledge. Their great number and variety require systematic arrangement; without which the necessary distinctions could not be made, and which, in some cases, where the difference is very minute, would be productive of great inconvenience.

O

§ XII. *Criteria*

§ XII. *Criteria of Natural Bodies.*

IN order to discriminate with safety and precision, even where bodies are united in the greatest affinity, it is an object of the first importance to establish proper *criteria*.

§ XIII. *Constant and perpetual Forms of Organic Bodies.*

IN the egg, or in a fecundated germ, the little body, the rudiment of the future fœtus, lies wholly concealed, until by proper heat and nourishment it is gradually evolved, increases, and arrives at maturity. In all organic bodies, therefore, the form is predetermined from their very origin, which the power of their internal and peculiar structure is calculated to develope; so that between these two qualities the relation is invariable; and therefore criteria are not improperly collected from that external figure which is derived from, and rooted in the essential character of the species.

§ XIV. *Monstrous Productions.*

AMONG these, indeed, we sometimes find deviations from the general laws of nature, producing *monsters*; but such events which are rare,
and

and arising from particular causes, are almost always unlike each other.

§ xv. *Fossils.*

ALL unorganic bodies, as well solid as liquid, which are either altogether without any organic structure, or display the ruins only of organization, are denominated *fossils*, or more commonly *minerals*.

§ xvi. *The Mineral Kingdom.*

THE term *fossil*, or *mineral kingdom*, is generally applied to an arrangement of such fossils as are found in the earth.

§ xvii. *Generation of Fossils.*

IN this third kingdom of nature, the process of generation is carried on in a manner widely different from that of organized bodies. Here is no egg, no seed, to cherish and support the future fossil, confined and restrained within the narrowest limits; no fecundation; no established circulation of the nourishing fluids; nor any evolution. Molecules uniting, by the sole

power of attraction, form at once the growth and perfection of fossils.

§ XVIII. *Variable and inconstant Form of Fossils.*

FORM, and other external qualities, of which the senses only can determine, depend upon circumstances that are perpetually varying, but which do not in the least affect the intrinsic nature of the fossil.

The position may possibly need the illustration of an example. Let us take a quantity of water, charged with aerated calcareous particles, and we shall see arise various figures, textures, and cohesions, according to the different modes in which the concretion was performed. By the subsidence only of the atoms a crust is generated, parallel to the bottom, if the distribution of them has been made equally throughout the whole mass; if otherwise, the greater part forms tubercles farther from the surface of the bottom, than in the supposition of equality. Water impregnated with aerial acid acts like a menstruum; and, though it does not at all affect the saturated particles in this hypothesis, yet it nevertheless has considerable influence in forming their concretions. Such water oozing through subterraneous vaults, generates calcareous drops, hanging from the roof, while
pointed

pointed cones are produced by the falling fluid upon the floor, and both increasing in length, meet at last, and form one continued column.—If the same water pursues its trickling course along the walls, we find them covered with a stalagmitic crust; which according to the diversity of the protuberances exhibits a great variety of figures, that, with the assistance of a warm imagination, may be made to resemble complete animals, or their several members, and a thousand other forms and appearances.—From this water suffered to remain long at rest, spataceous crystals are separated, that assume various shapes; as the granatic, the schoerlaceous, hyacinthic, dodecaedric, and those pyramidal on both sides, named swines teeth,—and many others.

The internal texture likewise admits of considerable variation. The most subtle particles unite into a dense and equal mass: Those that are granulous, and of many angles, form combinations more rough and uneven; such as are produced by chrySTALLIZATION appear spataceous; and others that are alternately deposited in strata, or lamellæ, present a divided structure.

The degrees of cohesion also vary according to circumstances. Water charged with fine particles of aerated chalk, and quickly evaporated, leaves a powder scarcely cohering, and which soils the fingers, like the mineral known

by the name of Agaric. Larger masses however of calcareous powder, exposed for many years to the pressure of a considerable weight, acquire at length such a degree of consistence, that distinct lines can be drawn with small pieces of them; indeed this property is found in calcareous chalk likewise.—Hitherto the greater degree of hardness has been produced by crystallization, as we find that calcareous crystals make no mark whatever, a circumstance owing to the firm union of their particles, by which the friction on a painter's canvass has no effect upon them, at least so as to be visible.

What has been thus briefly stated may be sufficient to satisfy us, that, from the external qualities of fossils, no proper judgement can be formed of their internal composition.

OF THE SEVERAL CRITERIA OF FOSSILS.

§ XIX. *Oryctology.*

ORYCTOLOGY, or Mineralogy, are names given to that science, which so arranges all the known fossils, that they may be accurately distinguished from each other.

§ XX. *Various*

§ xx. *Various Systems of Oryctology.*

As zoologists, in their arrangement of animals, have chosen different parts; some the feet, others the teeth, the beaks, and other parts, according to the agreement or disagreement of which their different systems were established; and, as botanists have differed in the principles of their science, one preferring a leaf, another the petals, a third the stamina and pistillum, while a fourth maintains the superiority of the fruit;—even so is it with mineralogists, who have often pursued very different paths, in their endeavour to illustrate and confirm the same object. Such a view of natural bodies, taken as it were from many different points, has however its advantages, as it increases the number of accurate comparisons. But, as every method cannot equally answer the end proposed, it becomes necessary to select that which is the most perfect and convenient.

§ xxi. *The best Arrangement.*

As, in order to understand the nature of fossils, and apply them to purposes of utility, it is necessary to arrange them in some kind of systematic order, the preference is certainly due to that method, by which both their internal character

rafter and composition may be made equally evident. Essential properties depend on the quality of the parts that enter into composition, and their mutual proportion; and, unless we are well acquainted with these parts, we shall labour to little purpose, in our attempts to mould them to our own desires: Nay, we often meet with disappointments, because we have not considered that our views are inconsistent with the very nature of the materials subjected to experiments.

§ XXII. *In what manner the Composition of Fossils may be ascertained.*

HAVING settled these points, it remains yet to be determined in what manner we are to judge of the *composition* of fossils: Whether the connexion between superficial marks, and the intrinsic character, is so intimate and consequent, that the former cannot be known, without the other being revealed? whether it may be necessary to proceed by a chemical analysis in the dry way? or, should this not be sufficient, are we to have recourse to the moist way? We will consider these questions separately.

§ XXIII. *External Criteria.*

IF, through the means of criteria collected
from

from the external appearance, and obvious to all, we were able to obtain the object of our research, no method could certainly be more simple; for, with the assistance of our senses only, we might dispense with the tedious processes of experiments: But we have already discovered the fallacy of relying on many of these marks, even the most principal, as they are liable to be affected by various circumstances of situation, and diversified without end, (§ xviii.). It may be proper, therefore, to enter a little more minutely into the consideration of this question.

§ xxiv. *Uncertain and deceitful Size of Fossils.*

IN no criteria can we possibly have less faith than in that of magnitude; and we cannot sufficiently express our astonishment at the violence offered to nature, when a larger piece of stone, referred to its proper genus, if reduced to a powder, is not only exiled to some other, but is not even permitted to remain under the same class.

§ xxv. *And Colour.*

THE vulgar proverb, that cautions us against belief in colour, is not inapplicable to oryctology. It is well known, that there are seven primitive colours; and, in order that a body appear coloured, it is requisite that some particular

cular kinds of rays be reflected ; would we enquire into the cause of this phenomenon, we must seek it in the quality of the surface, which is indeed often so transient, that the colour may be changed, or entirely destroyed by the heat of boiling water, or even by the influence of solar light.

A transparent colour arises from transmitted rays, and seems to indicate a species of attraction ; while, on the other hand, an opaque colour implies repulsion. Both without doubt suggest the idea of some relation between the light and the given body ; but which is of such subtlety, that though it alone were varied, the character of the matter remains altogether unaltered ; at least the difference is not obvious to the senses. We have seen, that transparency depends upon the disposition of the particles ; and this once disturbed, the transparency vanishes, and with it all the effect produced by transmitted rays. These several appearances seem to arise from the phlogistic molecules, which vary either as to quantity, magnitude, or elasticity. Velocity even determines the difference of colours.

§ XXVI. *Internal Texture and Form.*

WE have already touched on *internal texture and form* in the foregoing divisions, (§ xviii.)
Determinate

Determinate figures bear a resemblance to geometric bodies, and it is not without some degree of probability that they are said to be derived from the nature of the matter: An opinion that has long influenced many to believe, that certain figures were proper and essential to different substances. The folly of this doctrine I have elsewhere demonstrated at large *. If therefore regular figures, and those best defined, are fallacious, we are surely not to rely on any superficial characters which are very often common to substances of the most opposite qualities, and never uniformly constant in the same species.

§ XXVII. *Physical Marks of Earths.*

NOR are we wholly to neglect the *physical marks*, which, though they cannot be fully estimated by the external senses alone, yet may be ascertained by easy experiments, without the trouble of decomposition. Such, in the first place, are hardness and specific gravity; to which, indeed, we may add the relation to the magnet.

§ XXVIII. *Hardness.*

DEGREES of hardness may be determined in various ways, by the nail, the knife, or by steel;
and,

* Essays, vol. 2.

and when they are more intense, by a series of gems, cut expressly for this purpose. But this property indicates less the matter, and its mixture, than the various exsiccations arising from different circumstances, the subtlety and cohesion of particles, density, and such like. Soft clay dried gradually, and afterwards exposed to an increasing fire for several hours, until it is brought to a white heat, becomes harder and harder, and is at length capable, like a flint of striking sparks from steel. In all this process, however, the matter is no otherwise affected than by a contraction of its bulk, which is diminished about one half.

§ XXIX. *Specific Gravity.*

SPECIFIC gravity is determined by the hydrostatic balance, which properly indicates nothing else than the density or quantity of matter in a given volume. A knowledge of this property is of considerable utility, especially in the examination of metals, whether pure, or of known mixture; but with respect to other fossils, the difference is so very trifling, that their nature and composition can scarcely ever be this way ascertained.

§ xxx. *Examination by the Magnet.*

IRON, unless it is dephlogisticated below a certain point, is ever obedient to the magnet; but this mark is particular. Various phenomena likewise authorise a suspicion that many other substances are attracted by it; therefore no reliance can be had upon this as a distinguishing character.

§ xxxi. *Real Utility of external and physical Marks.*

ALTHOUGH superficial criteria contribute nothing to the true knowledge of fossils, and that the observation of Juvenal, *fronti nulla fides*, may be well applied to them, even though the physical properties be at the same time understood, (§ xxviii. xxx.) yet we are not altogether to pass them over in contempt. By such accurate determinations as the celebrated Werner so successfully attempted, they are rendered very proper for distinguishing varieties; and when the eye is once habituated to them, they often lead it directly to diacritic experiments. Perhaps the composition being thoroughly ascertained by analysis, an exact comparison may assist considerably in drawing a just inference.

§ xxxii.

§ XXXII. *Nature of Fossils discoverable by the Aid of Chemistry.*

IN order to discover the proximate principles of fossils, it is necessary to have recourse to chemical experiments. But will not the simpler kinds be sufficient, in which the fossils, whether alone, or with the addition of proper fluxes, are melted in the fire and treated in various ways? This indeed is the path pursued with indefatigable zeal by the celebrated Pott, and which no one since him has extended with more success than the renowned Monsieur D'Arcet. How far it is connected with our design we shall presently have occasion to observe.

§ XXXIII. *Their Character in the Fire.*

A THOROUGH knowledge of the effects produced by fire upon fossils is of the greatest importance in the cultivation of many arts. For if we recollect that bricks, tiles, crucibles, glass, amassa, earthen and china vessels, eliquation of metals, and other works, can neither be carried on nor completed without the assistance of fire, we shall see that this knowledge is equally necessary and extensive.

§ XXXIV.

§ XXXIV. *Use of the Blow-Pipe in Oryctology.*

NOR can we pass over in silence the great utility of the blow-pipe in oryctology, by its speedy and concise mode of operating. With it a few minutes are sufficient to examine the nature of a fossil, upon a piece of coal, or in a spoon of gold, and to observe all the changes from beginning to end; which for the most part is not possible in a crucible; notwithstanding in this way, it requires several hours before the result of the process can be known*.

§ XXXV. *Most of the Principles of Fossils are discovered by Fire.*

IT must, however, be acknowledged, that, in many cases, the principles of fossils may be ascertained by the proper application of fire; unless, by the number or delicacy of such principles, the composition of the fossil is rendered too complex and intricate.

§ XXXVI. *But not every Principle.*

THERE are many circumstances that will prevent us from considering fire as the supreme arbiter of composition, though supported with all
the

* Essays, 2d vol. page 455.

the assistance of the dry way ; and it may be sufficient to enumerate some of the most considerable.

§ xxxvii. *Why Investigation by Fire is sometimes fallacious.*

FIRE tends to confound all principles together, except those of metallic bodies which are separated from their matrices ; it is therefore not at all calculated to extricate the several ingredients of composition.

§ xxxviii. *The Efficacy of Fire cannot be defined with any certainty.*

AN accurate and easy measure of the power of this element is yet wanting. A fossil resists a certain degree of heat, that will yield to one more intense ; and there are perhaps a very few that are deemed altogether refractory.

§ xxxix. *And it is variable also.*

It is not uncommon for the same degree of fire to melt some varieties of the same species, while upon others, it seems not to have the smallest influence. The petrosilices, felspat, and other fossils, afford examples of this kind.

§ XL.

§ XL. *Does not determine the Proportion of the different Principles.*

AND lastly, if sometimes it is competent to discover single principles, yet it always conceals their mutual proportions. This imperfection is of the greater moment, as it is evident, that the proportions of the same materials being varied, both the appearance in the fire, and the other qualities of the fossil, are often considerably altered.

§ XLI. *Merit of Cronstedt.*

THE celebrated Cronstedt, in his excellent system of fossils, has established the superiority of principles, and has therefore conceived the genuine method; and if, notwithstanding, he has occasionally fallen into errors, they must be attributed to the want of proper experiments.

§ XLII. *The best Method of examining Fossils in the Humid Way.*

THE illustrious Margraf had no sooner discovered the true method of decomposition, the humid and menstrual, than he endeavoured, by his own exertions to render it easy and practicable. The new road into which he struck, was beset with thorns and briars; but it is certainly the

P

only

only one that leads to a knowledge of principles, both as to quality and quantity; and therefore indispensably necessary in every enquiry into composition.

§ XLIII. *The Difficulty of founding a System of Fossils.*

It was the opinion of the celebrated Lehman, whose judgement in such matters was unquestionable, that a thousand years would not be sufficient for the construction of a system of fossils, arranged according to proximate principles, on account of the immense number of various fossils, and the daily augmentation it is receiving; the variety and expence of the necessary experiments, and the want of a more general spirit of adventure and industry requisite for such an undertaking.

§ XLIV. *Internal and external Characters.*

A collection of those properties on which the leading principles depend, is called the *internal character*; and the chief superficial marks of any fossil taken together, constitute the *external character*.

OF

OF THE CLASSES OF FOSSILS.

§ XLV. *Enumeration of the Classes.*

AVICENNA, an Arabian physician of the eleventh century, divided fossils into the four classes, of salts, earths, metals, and phlogistic bodies. In this division, all substances agreeing either in external or internal character, are properly enough combined; and, as hitherto no general arrangement has been proposed preferable to this, it is no doubt worthy of being continued.

§ XLVI. *Order.*

THE order of the classes may in a great measure be treated as a matter of indifference; however, I think it right to begin with Salts, as being the only substances soluble in water, and which ought to be thoroughly understood, in order to develop the nature of the other classes; and perhaps, because they are radically united with each of them, though the most considerable number of them have as yet in this state escaped discovery.

Phlogistic bodies I place the last in order; for these by their prevailing principle approach nearer than any of the other classes to organised bo-

dies, charged with inflammability, and to which principle fossils perhaps are indebted for their existence. Earths and metals, according to their character, hold with propriety a middle station.

§ XLVII. *Distinguishing Marks of each Class.*

For the present it may be sufficient to mention the following criteria of the classes, which shall afterwards be more fully explained.

Salts very finely pulverised, and dissolved in a thousand times their weight of water, are more or less sensible to the taste. With respect to distilled water 2 is the common limit of their specific gravity.

Earths have neither taste nor solubility. They are however taken up by proper simple salts. Though for the most part heavier than salts, they are not reducible to a metallic state. When compared with water, their specific gravity fluctuates between 3 and 4 $\frac{1}{2}$, which it has never yet exceeded.

Metals are not soluble in water; have a peculiar splendour; and surpass all other known bodies in specific gravity. They are at least six times heavier than equal bulks of water, commonly much more; but never exceeding twenty times.

Phlogistic bodies are almost always lighter than

than the salts ; but have this peculiar quality of being combustible.

§ XLVIII. *Taste.*

TASTE, depending upon the sensibility of the tongue, differs so much in different persons, that what will excite powerful sensations in one man shall not be at all perceptible to another. It is evident, therefore, we are to place but little dependance on this quality.

§ XLIX. *Solubility in Water.*

SOLUBILITY in water, considered generally, is an *unlimited property*. In order to define it, it will be necessary to attend to the state of division of the body to be dissolved, and the quantity and temperature of the menstruum employed.

Pulverization encreases the extent of surface ; and in proportion as it does so, the menstruum, by coming into contact in a greater number of points, acts with more efficacy. For this reason large masses immersed in a menstruum, are sometimes very little, if at all corroded : When divided into small pieces they offer less resistance ; and, if pulverized are entirely dissolved. It happens occasionally, however, that mechanical division does not answer the end effectually,

and therefore recourse is had to the more subtile powers of chemistry; and the precipitation of a solution made in a stronger menstruum, is taken successfully for this purpose. For a precipitate yet moist and recent is so open and spongy, that it far exceeds all mechanical division.

In like manner, though a solution cannot be effected in an equal weight of water; yet, if that weight is doubled or tripled, or sufficiently increased, there would be no doubt of producing it.—If water of a moderate temperature avail nothing, tepid or warmer water may succeed; and should this degree also of heat be ineffectual, it may yet be raised to such a height in a close vessel, as will generally overcome all resistance, and even produce effects scarce to be expected.

Hence, then, I apprehend it is evident, that the very nature of solubility will not admit of any certain or determinate criteria, but that it may be said rather to proceed in an infinite series: For if, on instituting an experiment, nothing is dissolved, a suspicion will always arise that if the resisting matter were either more minutely divided or immersed in a greater quantity of water, or in water of a higher temperature, it would necessarily be dissolved. In this manner, therefore, all certainty is destroyed, and every conclusion rendered merely conjectural.

§ I. *Artificial Limits of Solubility.*

IF solubility ever becomes an useful criterion, it must be by assigning to it certain necessary artificial limits. Having duly considered this idea, I have pronounced those to be the best, that can be found most easily every where. I have selected therefore for this purpose mechanical pulverization, a weight of water a thousand times heavier than the substance to be dissolved, and a degree of heat equal to boiling, as boundaries more proper than any others.

§ II. *Great Extent of Solubility.*

WE are very far from believing that this limit is to interrupt one link in the great connecting chain of nature. Our ignorance and weakness have rendered it necessary; and, whatever substances beyond it a more improved state of science may discover, we shall refer them to the class of earths, though we give them the appellation of saline, as an indication of their character. As examples of such saline substances, we may take the siliceous earth, which is found absolutely dissolved at Geyser in Iceland*; and the zeolithic, at Laugarnaes in the same island†.

P 4

Vitriolated

* Essays, vol. 3d. p. 251.

† Ibid. p. 255.

Vitriolated ponderous earth, commonly called *spatum ponderosum*, aerated lime *, fluorated lime, impregnated with the acid of the *lapis ponderosus* †, are all saline earths, by the force of composition, and are even without doubt soluble, though to what extent experience has not yet determined.

§ LII. *Distinguishing Marks of Earths.*

THE characters of earths are of the negative kind. An earth is that substance, which is not soluble; not so heavy as metallic bodies, nor is capable of combustion. Criteria such as these betray our very limited and imperfect knowledge. Cronstedt indeed mentions another mark, the malleability of earths; but this observation may be applied to salts, phlogistic substance, and the brittle metals. As to their form not being changed by a red heat, the same can be said of the vitriolated vegetable alkali, of metals that require a much greater degree of heat for their fusion, and of other fossils. Any expansion of their bulk is scarce perceptible to the eye, though a red heat is always sure to produce it, unless counteracted by the dissipation of some volatile matter, as in clay, aerated lime, and other substances.

§ LIII.

* Vol. i. p. 26.

† Vol. iii. p. 228.

§ LIII. *Metals.*

PERFECT metals are easily distinguished by their opaque shining surfaces and specific weight. Their malleability, which Cronstedt considers as their peculiar character, is no general criterion; for we reckon almost as many brittle as ductile metals.

§ LIV. *Phlogistic Substances.*

A CERTAIN degree of levity, with as much phlogiston, loosely combined, as will occasion inflammation, is necessary to the constitution of all bodies denominated phlogistic. Solubility in oil is not a distinguishing property of this class; as that menstruum, though producing no effect on plumbago, yet acts violently on lead, copper, arsenic, and other metals.

§ LV. *Mixed Fossils.*

WHILE we are giving our attention to the distinct arrangement of the several classes, it will be easily seen that we mean to consider such fossils only as are in a state of purity; that is to say, free from every corruption by combination with the subjects of other classes, not necessary to their composition. Sulphurated metals, for example, belong to two classes; and we are
to

to determine from other data, to which they ought in preference to be adjudged. In like manner, aerated and fluorated lime, muriated silver, and some others are to be considered.

§ LVI. *Affinity of Fossils.*

By the law of continuity, we may observe a great affinity among the several classes of fossils.

§ LVII. *Affinity of Salts with Earths and Metals.*

WE have already taken notice of the connexion of salts with earths, and we may add further to our remarks on this subject, that burnt lime, by the intermedium of the matter of heat, acquires a solubility perfectly saline. The same thing happens to ponderous earth, but not to magnesia. In all metals there lurks a certain acid peculiar to each, the nature of which we have as yet explored in arsenic only. These metallic acids differ from all others in this respect, that, when taken with proper proportions of phlogiston, they become metallic calces; but if saturated with that principle they are reduced to a perfect metallic state *, generating at the same

* Essays, vol. 3. p. 124.

same time sulphur and aeriform fluids *. Most phlogistic bodies likewise, perhaps indeed all, contain an acid united in their very constitution.

§ LVIII. *Affinity of Earths with Metals.*

EARTHS resemble the calces of metals in many of their properties; but in respect to specific gravity, the faculty of colouring glass, and their reduction to the metallic state, they are essentially different.

§ LIX. *Sulphureous Character of Metals.*

METALS in their perfect state are either metallic acids saturated with phlogiston, or a species of metallic sulphur, which are sometimes very evidently susceptible of inflammation, as zinc and arsenic. Gold and copper, when in fusion, afford some appearance of flame, though faint, in a greenish vapour; bright sparks are emitted from iron in a white heat; and tin also may be inflamed by a proper manner of operating.

§ LX. *Stones.*

IN the classes already enumerated, all fossils are by no means included. Such as are composed

* Essays, Vol. ii. p. 352.

fed of heterogeneous substances, mechanically mixed, and united in a visible manner, and which, for the most part, constitute the entire summits of mountains, are comprehended under one name of *Petræ* or *Saxa*. Cronstedt has, with great propriety, treated these separately in an appendix. The knowledge of these substances is doubtless highly necessary, and tends much to the illustration of physical geography; but they are not therefore to be confounded with bodies more homogeneous, whose combination resting on chemical principles, is effected in the way of solution.

§ LXI. *Organic Fossils.*

ORGANIC fossils are considered by Cronstedt in another appendix. These substances are to be treated as strangers from the animal or vegetable kingdom. They are distinguished by an organic structure, more or less imperfect; of which, as long as they bear any marks, we are to reckon them as fossils of a foreign species. The consideration of them is however in various points of view, highly useful. They resemble a series of ancient coins in the testimony they bear to the convulsions and revolutions of our globe, on which historical monuments are wholly silent. From them we may learn the wide extended sovereignty of the sea; the changes
that

that successive ages have wrought upon the surface of the earth; and they disclose to us what animals inhabit the deep abysses of the ocean, and many other circumstances most worthy the attention and enquiry of philosophy.

§ LXII. *Volcanic Productions.*

THOSE burnt substances thrown out from the mouths of volcanos, by a greater or less degree of subterraneous fire, Cronstedt has thought fit to arrange in a third appendix. A general view of them no doubt would be useful; but there are not wanting many reasons why, in my opinion, volcanic productions will not admit of a separate classification. We know there are many who strenuously support the hypothesis, that the whole fossil kingdom owes its origin to fire; for such as these, therefore, any distinction will be unnecessary. We have learned also, that marks burned by fire into fossils are gradually obliterated by the injuries of time; becoming first obscure, then equivocal, and at length being wholly destroyed. Whatever limits, therefore may be drawn, they are in their very nature transient and perishable. It is, and must be often exceeding difficult to determine whether fossils have derived their existence from solution, or from the effects of fire. Accordingly, to me it seems proper, to insert homogeneous volcanic

volcanic productions into classes agreeable to their principles; and that all those heterogeneous substances, whose combination is visibly mechanical, should be the subject of the first appendix.

OF GENERA.

§ LXIII. *Arrangement of Genera.*

By the assistance of classes, all those fossils are connected, whose composition, character, and properties are perfectly similar. Genera require a nearer affinity; species a resemblance still closer; and varieties must correspond in their internal habitudes only.

Fossils entirely homogeneous are of very rare occurrence; as, for the most part, two, three, or more principles, enter into their composition.

The more simple their composition, it follows, they will be the easier reduced to their natural genera.

Let A and B be the proximate principles of any fossil, let A be heavier than B, the compound A B, will be then referred to the genus of A; but this admits of various exceptions.

Suppose B possessed of a generic difference, and that it is no where found in a single state, (for we do not here speak of artificial separation,)

on), but always united to A, or some other matter, and ever inferior in weight in such combinations. According to the rule proposed above, the genus B should disappear entirely, and be altogether wanting in the genera of its own class, which is by no means consistent with a natural system.

Again, let us suppose B excels A in the intensity of its properties, so that B is only equal

in weight to $\frac{A}{N}$, yet notwithstanding the quali-

ties of B are clearly predominant in the composition A B, that is, are much more conspicuous than those of the less ingredient A. Here again, unless I am deceived, we are to admit another exception.

If the cases proposed under B and C obtain at the same time, the exception receives a double confirmation.

Sometimes it seems necessary to give a preference to the price of particular substances. Suppose A B C an ore, whose metal C, though of less weight than any other part of the mixture, yet in value surpasses both B and A, so that they are entirely neglected, and C only thought worthy the expence of metallurgic operations. In this case A B C is in fact the ore of C; but if the proportion of quantity were regarded, it should belong to the genus of A, and with great propriety, if a natural system only is required.

We

We are not here to have any respect to fictitious valuation. But as the arrangement of fossils is made with a view that our knowledge of them may be eventually useful and advantageous, it may seem to militate against this design, if we were to seek among the baser kind for all those noble minerals, whose intrinsic value can defray the labour and cost of eliquation.

The several cases proposed ought not to be considered as imaginary, as they each of them occasionally occur, and will be rendered more clear and intelligible by application in the following sections.

§ LXIV. *Genera of Salts.*

In salts, we discover two genera, by no means ambiguous; the acid, and the alkali. Chemistry has not yet been able to extract their proximate principles; but, that they are different from, and opposite to each other, there is not the least room to doubt.

§ LXV. *Acids.*

AN acid is easily discoverable by the taste, by its property of changing to red the blue vegetable colours, and of effervescing with aerated alkalis.

§ LXVI.

§ LXVI. *Alkalis.*

ALKALIS are distinguished by a burning taste, by their conversion of blue vegetable colours to a green, and by their powerful attraction for acids.

§ LXVII. *Salts not saturated.*

UNSATURATED combinations of acids and alkalis, enter the genus of the prevailing substance, unless any one should chuse to refer them rather to the imperfect neutral salts; which might be done not altogether without reason, as the most of them betray an excess of either the one or the other ingredient.

§ LXVIII. *Whether neutral Salts are to be referred to a distinct Genus.*

It may be questioned whether an acid exactly saturated with an alkali should constitute a distinct and separate genus? Or ought rather such a combination to be ranked under the acid, or the alkaline salts? If there is evidently an excess of either of these principles, as in § 75, then, without doubt, it may be properly assigned to the genus of the exceeding principle; but, in all perfect neutral salts, the properties of acid and alkali are blended so intimately by saturation, that all distinction between them seems en-

Q

tirely

tirely to have disappeared. In this state of equilibrium, then, it becomes a matter of indifference whether the preference be given to the acid or the alkali. To the latter however I should rather incline, as the most convenient; but I would not violently oppose any one who might think proper to refer them to the acid, or to a distinct genus. Quantity may in this case, in some measure, assist our determination; but not without irregularity: For, as the pure fixed alkali is saturated with a weight of acid less than its own; so, on the other hand, the volatile alkali requires the acid to be heavier than itself.

§ LXIX. *Mixed Neutral Salts.*

It may happen, that the same acid is partly saturated with one alkali, partly with another; and yet nevertheless, these three are so strongly united by crystallization, as to constitute but one peculiar salt. The salt of Seignette affords an instance of this species of composition; the cream of tartar likewise saturated with volatile alkali. That the same alkali may be combined with two acids, the union of cream of tartar with the acid of borax sufficiently demonstrates. In the fossil kingdom, indeed, we find none of these triple salts; but they inform us what may be done towards establishing a general arrangement. The salt of Seignette, with the acid of
borax

borax, produces a quadruple salt ; and it is not unlikely, but that the industry of future ages will discover combinations of five principles, and perhaps of still more ; the disposition and order of which may be determined by the character and quantity of the several ingredients.

§ LXX. *Analogous Salts.*

FOSSILS of the second and third class become true saline substances, by combination with any salt ; and in this condition they are banished from their original classes. Salts, such as these, are called, analogous ; and according to the character of their bases, are of two kinds, either earthly or metallic. Whatever imparts the saline nature ought to determine the genus.

§ LXXI. *Other Combinations of Salts.*

ALL earths almost as well as metals are not only taken up by acids, but several fossils besides, of both classes, are dissolved by alkaline salts, and some even by neutral salts ; nay, it happens occasionally, that two double salts will unite into one, and form a salt of four principles. From such multiplied and various combinations proceed, alkalis and acids charged with earths and metals ; double neutral salts, or salts of more principles, containing earths and metals ; double earthy salts united with double metallic salts,

which, according as the saline matter is either the same or different in each, generate triple or quadruple compounds.

§ LXXII. *Doubtful Genera of Salts.*

IN the class of salts it often happens, that some principles are never found in a single and independent state, but united always with others. Such are, for example, the nitrous, the muriatic, and arsenical acid. It may be doubted, therefore, whether these substances are to be considered under their simple genera. As, however, it does not seem improbable, that they were once free and uncombined, we are hardly authorized to exclude them; though it may be, at the same time, observed, that they have never yet been found otherwise than in this state of combination. At all events, the investigation of simple substances will throw light upon the several compositions.

§ LXXIII. *Genera of Earths.*

SOME genera of earths have hitherto resisted all attempts to reduce them into simpler principles; while others, by a proper analysis, have discovered two or more. The former are called *primitive*, the latter, *derivative* earths.

§ LXXIV.

§ LXXIV. *Primitive Earths.*

CRONSTEDT has established nine primitive earths, but accurate experiments have since shewn that the greater number of them were compounded, so that the account is reduced to three only; the calcareous, siliceous, and argillaceous. We have however to add new earths, with which he was not acquainted, the terra ponderosa and magnesia. We reckon therefore five primitive earths.

§ LXXV. *Of the common Origin of Earths.*

ALTHOUGH the powers of chemistry have not yet been able to decompose these five earths, the reduction of them all to one species, or, at least, to a smaller number than the present, may possibly be the reward of future industry. I acknowledge myself of this opinion, and I think with some foundation. Clay, for example, is nothing else than calcareous earth, so strictly combined with some unknown acid, that the separation of them has hitherto been attempted in vain. No one certainly could have suspected the calcareous base in the *lapis ponderosus*, which has been demonstrated by analysis. In like manner, other substances may be investigated. But until proper experiments shall have fully developed the nature of such compositions,

they must be, in respect to our knowledge of them, considered as primitive substances : For it is wholly inconsistent with the caution and diffidence of natural philosophy to advance any position upon a bare possibility. Daily experience sufficiently teaches, that those things which at one time appear highly probable, may at another be discovered to be entirely unfounded.

§ LXXVI. *Reasons why the Terra Ponderosa ought to be referred to a distinct Genus.*

THE ponderous earth, on account of its great specific gravity, is deserving of particular attention, and leads us naturally to apprehend it to be of metallic origin. Other arguments also support this hypothesis. It is admitted, with the force of an axiom, that phlogisticated alkali precipitates metallic solutions only : But if this alkali is dropped into a solution of acetated ponderous earth, it is immediately disturbed, and a white powder is precipitated ; which, on examination, is found to consist of that earth vitriolated, from the vitriolic acid inherent in the Prussian blue. If the powder is separated by means of a filtre, and a new portion of acetated ponderous earth added to the liquid, on exposing it to the fire, the solution, though clear before, deposits another white powder, containing the ponderous earth united with the phlogistic alkali. The result is the same if the ponderous earth

earth, saturated with the nitrous acid is treated in a similar manner: Therefore it seems rather to resemble a metallic calx than an earth, by these properties.

Among the metallic calces, that which arises from lead corresponds with the ponderous earth in its weight, its white colour, and peculiar attraction for the vitriolic acid, by which that acid is torn away from alkaline salts; but there is notwithstanding a remarkable difference between them. Acetated lead is disturbed wholly in the cold by phlogisticated alkali, and deposits a sediment, which neither is soluble in water, nor in the vitriolic acid; but the acetated ponderous earth yields its genuine precipitate by heat only, and which is soluble both in the vitriolic acid and in boiling water. Besides, this earth has hitherto resisted all efforts to reduce it to a metallic state.

Therefore, although there may appear a considerable affinity between the ponderous earth and a metallic calx; yet, as long as it is incapable of reduction, its metallic nature is certainly not sufficiently demonstrated, and it must still retain a place among the earths.

§ LXXVII. *Five Genera should be constituted of the five primitive Earths.*

As we have enumerated already five primitive earths, they naturally become the heads of

five distinct genera. It is very rare, if ever, that they are found in a simple state, being either combined with one or more of the other earths. The most easy method, therefore, would be to determine the genus of every such composition, according to the heaviest principle; but the cases before separately stated, in § lxiii, are often objections to this plan.

§ LXXVIII. *Exceptions.*

WERE this rule once admitted, we should lose altogether the magnesian and argillaceous genera; for, in the compositions hitherto examined, into which those earths enter, the siliceous has been always found to outweigh the others, although, from their character and properties, they had both the superiority. Common clay contains above half its weight of siliceous earth, sometimes above three fourths, and yet the argillaceous qualities are so distinct, that these compositions are unanimously denominated argillaceous. The same richness and pre-eminence of quality, with respect to the siliceous earth, are found in magnesia, and other substances.

All earthy compositions, therefore, may be determined by the genus of that ingredient, which exceeds the others in weight, unless it be siliceous, and not equal to seven-eighths of the whole. In such cases, the genus ought to be ascertained

ascertained by whatever ingredient approaches nearest in weight to the filiceous.

§ LXXIX. *Compound Earths are not united mechanically only.*

BUT perhaps, all earthy compositions are nothing else than many subtle mechanical mixtures? At the very first view indeed there seems some foundation for such an opinion; but a more minute investigation furnishes evidence of a closer union constructed on other principles. The earth of alum immersed in lime-water, and entering into so strict a combination with the lime as not to be separable but by chemical art, teaches us, that among primitive earths mutual attraction has a real existence. Besides, as almost all these mixtures generally form crystalline concretions, we have another proof, not only of the minuteness of their particles, but of an union perfectly homogeneous.

§ LXXX. *Genera of Metals.*

IN the third class we are to constitute as many genera, as we have known distinct metals.

§ LXXXI. *Increased within a few Years.*

AT the beginning of the present century,
eleven

eleven metals only were known ; but it had scarce grown forty years older, before the discovery was made of platina, a noble and ductile metal, and of three or four others, that were not malleable, as cobalt, niccolum, magnesium, and siderum, which last has hitherto appeared to differ from all the rest *. The fifth in molybdena is not yet sufficiently explored, to determine whether it should be reckoned among those already known, or constitute a new species ; and to the sixth, in the acid of the lapis ponderosus, we may apply the same observation. Of these two, however, we are in hopes the character of the first will be soon displayed by the industry of Mr Hielm. The genera of metals, therefore, of which we can be certain, amount to sixteen, or fifteen at least ; and it is not unlikely that this number will be increased by future discoveries.

§ LXXXII. *Arrangement of mixed Metals.*

IN section lxiii. we have a question respecting the genera of minerals containing two metals, the one of which is more valuable than the other, but in less quantity. Examples of such minerals we find in the golden pyrites, which
hold

* Meyer and Klaprothius have proved it to be iron joined to the phosphoric acid ; and our author, convinced by their arguments, changed his opinion.

hold a small proportion of gold united with a large proportion of iron; among the galenæ, that are far richer in lead than in silver; among the copper pyrites, always producing more iron than copper; and so on of many others. According to systematic rules, the more valuable and scarcer metal, although it defray the expence of eliquation, should yet be referred to the genus of the more abundant, though of less estimation. But if the use and aim of any system is considered, there can be no doubt that the preference should be assigned to the metal of the highest value. In some degree, however, the determination of this point may be a matter of indifference, provided no distinct genus is thereby destroyed; a circumstance that would probably affect the siderite, in case it were decided in favour of superiority in weight, as that metal has never yet been found separate from iron ores, to which it always bears the smallest proportion.

§ LXXXIII. *Genera of Phlogistic Bodies.*

THE fourth class contains the fewest genera, sulphur, petroleum, amber, and perhaps diamond.

§ LXXXIV.

§ LXXXIV. *Sulphur.*

SULPHUR is an instance of the most simple composition, consisting of two principles only, acid saturated with phlogiston.

§ LXXXV. *Petroleum.*

IN petroleum we discover an union more complex; a small portion of water combined, by means of an acid, with the principle of inflammability.

§ LXXXVI. *Amber.*

THE origin of amber is evidently from the vegetable kingdom, for, besides its peculiar acid and oil, we obtain the acetous acid by distillation. The earthy residuum may be considered as a matrix.

§ LXXXVII. *Diamond.*

WITH regard to the diamond, I have hitherto found no place so proper for it as this class. In a sufficient degree of fire, it is entirely consumed, and with an appearance of cloud or flame; and, in the focus of a burning lens it discovers signs of a sooty matter.

§ LXXXVIII.

§ LXXXVIII. *Pyrites and Molybdena do not constitute peculiar Genera.*

I HAVE referred pyrites, or sulphurated iron to the genus of iron. In like manner, molybdena, which is nothing else than a metallic calx mineralized by sulphur, provided its genus were known, ought to be ascribed to the class of metals. As to the fossil considered by Cronstedt as fixed phlogiston, and which he calls *brandertx*, its composition has not as yet been sufficiently investigated.

§ LXXXIX. *Properly speaking, there is but one Genus of phlogistic Substances.*

IN the strictness of language, all the genera of this class might be reduced to one, as the same principle of inflammability prevails in each of them.

§ xc. *First Appendix.*

IN the first appendix to the classes, are treated those fossils of various and mechanical combination, and which for the most part is obvious to the sight.

§ xci.

§ XCI. *Four Genera of Fossils mixed mechanically.*

ANSWERING this description, we have four genera only, which are denominated according to the class of the most predominant ingredient in their composition.

§ XCII. *First Genus.*

THE first genus in which the saline character prevails occurs sometimes in the neighbourhood of volcanoes. In gypsum also other fossils intimately mixed are occasionally found. The substances likewise contained in natural waters may perhaps be referred to this genus. They are indeed held by water in solution, but their union is generally merely mechanical, of which the fixed principles are collected in the residua, after the evaporation of the liquor.

§ XCIII. *Second Genus.*

TO the second genus we assign all those fossils in which the earthy principle abounds. Such are those placed by Cronstedt in his first appendix under the name of *saxa*. Under this genus may be arranged several matrices of metals as well as of inflammable substances; for lithanthrax,

thraz *, aluminous schistus, aluminous ore of La Tolfa, and many others, contain some extraneous earthy matter, and in considerable quantity.

§ xciv. *Third Genus.*

IN the third genus, the metallic nature is predominant. It has been long observed, that some metals affect a disposition to associate with each other; so that if one is discovered, it may be properly conjectured that the other is not very far distant. Relations such as these, as are obvious in this genus, are worthy attention and enquiry, as they promise no small advantage to the inhabitants of mountainous countries.

§ xcv. *Fourth Genus.*

IN the fourth genus we meet with various mixtures of fossils, of which this ruling principle belongs to the last class.

§ xcvi. *Distinct and mixed Particles of Fossils.*

To this appendix likewise, the distinct and mixed particles of fossils may conveniently be referred, inserting them under their proper genera, according to circumstances. Such, for example

* Pit coal.

example are the marles, most of the common clays, mixed sands, and several others.

§ XCVII. *Four Genera of organic Fossils.*

LASTLY, Organic fossils are divided into four genera, as the diversity of their nature suggests, whether they are found impregnated with and composed of salts, earth, metals, or phlogiston.

§ XCVIII. *Fifth Genus of Cronstedt.*

CRONSTEDT adds a fifth genus, and perhaps with great propriety, in which are included all the dead remains of once living substances, which, by gradual putrefaction, have lost their original structure, though they still retain such strong marks of it as are not obliterated entirely but by the lapse of many years. To this genus belongs the earth of destroyed animals or vegetables.

§ XCIX. *Organic Bodies mineralized by Salts.*

THIS operation must vary according to the nature of the substance. Bodies immersed in a salt solution are sometimes penetrated by it, and indurated. In this manner the entire bodies of men, that had fallen by accident into the vitriolated water of the mine of Fahlun were found
after

after several years, so little changed to the eye, that the individual could be remembered by his countenance: In other respects however they were rigid like a statue, formed of saline matter. When exposed to the free air they began to crack. By a similar process, no doubt, even softer substances may be so hardened, as to preserve their structure a long time, exempt from putrefaction.

§ c. *Bodies impregnated with Bitumen.*

IN like manner organic bodies, impregnated with bituminous matter are enabled to preserve themselves from decay, and retain their figure and structure.

§ ci. *Petrification of organic Bodies.*

NEITHER the bodies of animals nor of vegetables can be wholly penetrated by stony particles. The harder parts only, as the bones, shells, external covering, roots, woods, fruit, and similar substances, are liable to this change; which, if I mistake not, proceeds in the following manner: At first, the parts of softest texture putrefy, and leaving several empty spaces, through which water loaded with earthy particles passes, and in its course depositing them, the vacuities are at length filled by their gradual accumulation. Then follows the destruction of the more firm consistence, to be penetrated in the same order.

R

If

If the later depositions differ in their colour and properties from those of an earlier date, yet the original organic structure is beautifully displayed by smooth and polished sections of the different bodies. All the particles, however, of the bodies so destroyed are not always carried off; for it often happens in distillation, that such are expelled as shew signs of an organic construction.

§ CII. *Organic Bodies penetrated with metallic Particles.*

THE most subtle metallic molecules, that can possibly be carried along by water, may in the same manner penetrate and change the harder organic parts.

§ CIII. *Nuclei.*

FROM the substances already described, nuclei have, with great propriety, been considered as quite distinct. They are produced by two different processes. Any body possessing a shell or firmer covering, and deposited in a soft stratum, is gradually attacked in its fleshy parts and soft intestines, which are either wholly destroyed, or contracted by exsiccation; so that room being made in this manner for the particles flowing in, the shell is at length filled with a nucleus, bearing the marks of its internal surface. If a body is involved in sediment, and after the exsiccation of the stratum is any way destroyed

destroyed or carried off, a nucleus will be formed in the cavity, describing its external features.

§ CIV. *Remaining Impressions of organic Bodies.*

IN any soft substance, impressions are left by cockles, snails, insects, fishes, and other small animals of the firmer kind, either of their external surface, their bones, or skeletons.

CV. *Osteocolla.*

IN particular soils, living roots are by degrees covered with so hard a crust, as to prevent the absorption of the necessary juices. When a vegetable attracts moisture every where in the neighbourhood of its root, the subtile, calcareous, argillaceous, filiceous, and even ochreous molecules, that accompany it, produce this effect. The fluid in which they were borne being absorbed by the roots, they fix themselves on the surface, and there forming a covering impervious to water, the roots decay, putrefy, and leave this crust, which is commonly called *osteocolla*.

§ CVI. *Incrustated organic Bodies.*

WATERS loaded with earthy particles frequently cover with a crust, reeds, small bran-

ches, and other substances immersed in them, without any alteration of their original form.

OF THE DIFFERENT SPECIES.

§ CVII. *Specific Characters of Salts.*

SPECIFIC characters are to be determined by the difference in the nature of those simple salts, which art has not been able to compose from their principles. Of these, two distinct genera only are known; the acid and the alkali already mentioned.

§ CVIII. *Species of Acids.*

THE genus of acids is very extensive. The vitriolic, nitrous, and muriatic, have been extracted from fossils for many ages past; but the discovery of others differing evidently from these has been made within a much later period. The acid of fluor, borax, arsenic, siderite, molybdena, and lapis ponderosus, are of this description*.

§ CIX. *Vegetable Acids.*

WE have the prospect as yet of a more extensive field in the acids of the vegetable kingdom.

Besides,

* For metallic acids, see Essays, v. iii.

Besides the acetous, which was the only one formerly known, it has produced to us already the acids of sugar, sorrel, tartar, benzoin, citron, amber, and several others.

§ cx. *Animal Acids.*

THE animal kingdom is the poorest of the three; for except the acid of ants, and of fat, we know of none other proper to it, although, without doubt, it contains many highly deserving of notice. As for example, the acid which the larva phalænæ vinulæ of Linnaeus throws out in its defence, clear as water, and colourless, which resembles the concentrated acetous acid in smell and taste, coagulates blood, and thickens spirit of wine; reddens blue paper for a short time; but the original colour returning afterwards, affords proof of its great volatility*. The scarcity of this very singular liquor has perhaps delayed so long its further investigation.

§ cxi. *Acids common to several Kingdoms of Nature.*

OTHER acids are common to all the kingdoms of nature, as the *phosphoric*, which had been falsely assigned to the animal kingdom alone; but which has been found, though rarely, in the fossil†, and in great plenty in the vegetable

R 3

kingdom.

* Oeuvres de M. Bonnet, v. iii. 8vo. p. 28.

† Essays, vol. ii. page 426.

kingdom. Under this head we may arrange the aerial acid.

§ CXII. *Great Number of Acids.*

If we consider, that probably the existence of all metals depend upon their peculiar radical acids; that vegetables evidently contain a number of unknown acids; and that, perhaps, the same may be said of animals also; we have reason to wonder at the abundance and variety of this substance, and to set a high value on its utility and importance in the œconomy of nature.

§ CXIII. *Species of Alkaline Salts.*

THE extent of the other genus is confined within very narrow limits. For a long time three species only of alkaline salts were known; two of which could bear a slight ignition, and were therefore denominated fixed; while the other was distinguished by its volatility.

§ CXIV. *Fixed Alkalies.*

OF the fixed alkalies the one seems to prevail in the vegetable, and the other in the mineral kingdom; from which they both derive their names.

§ CXV.

§ CXV. *Neutral Salts.*

SALTS formed by the exact saturation of acids with alkalies amount to sixty double species, on the supposition that the acids do not exceed twenty in number. A considerable part, however, of the combinations of these are as yet unknown, or at least but imperfectly examined.

§ CXVI. *Imperfect double Salts.*

MANY imperfect double salts have been discovered. The acids of vitriol, arsenic, tartar, and sorrel unite in excess with the vegetable alkali; and the acids of vitriol and tartar with the mineral alkali. The labours of posterity will probably add a greater number. Borax retains an excess of alkali; and the arsenicated mineral alkali likewise is capable of a similar combination.

§ CXVII. *Triple Salts.*

THE salt of Seignette, and tartar saturated with volatile alkali, furnish examples of the neutral triple salts.

§ CXVIII. *Imperfect Triple Salts.*

AMONG the triple imperfect salts, we know of the union of tartar with the acid of borax. Here is an excess of acid.

§ CXIX. *Quadruple Salts.*

TARTAR and borax combined, are an instance of the quadruple salts.

§ CXX. *Species of analogical Salts.*

EARTHS and metals, although singly they refuse every combination with water, yet by the admixture of a salt they become for the most part soluble, and are then called analogical salts.

§ CXXI. *Species of double perfect earthy Salts.*

FOUR primitive earths uniting with twenty acids, produce eighty double perfect earthy salts; that is salts compleatly saturated. The fifth earth, the filiceous, is soluble in the fluor acid only.

§ CXXII.

§ CXXII. *Double imperfect earthy Salts.*

OF all the double imperfect earthy salts, with an excess of acid, the salt of alum is the most conspicuous.

§ CXXIII. *Triple earthy Salts.*

THE principle triple compounds, are the volatile alkali, either vitriolated or muriated, and magnesia, with which even nitrated lime readily unites.—Vitriolated magnesia combines with clay; and both the vegetable and mineral alkali saturated with the acid of fluor, admit an union with filiceous earth.

§ CXXIV. *Earthy alkaline Salts.*

FIXED caustic alkalis, I know for certain affect no other earths than the argillaceous and filiceous. No triple alkaline salts have as yet been discovered.

§ CXXV. *Species of metallic salts.*

ANALOGICAL metallic salts are by far the most numerous. From a combination of the sixteen metals with the twenty acids, we obtain three hundred and twenty double salts;
but

but which can be scarcely so perfectly saturated, as that there should not be some small excess of acid.

§ CXXVI. *Metallic Salts, with an Excess of the metallic Base.*

THERE are some instances also of the union of metals and acids, highly deserving of notice, in which the excess is on the part of the metal. To this head we refer the turpith mineral, and red precipitate of Mercury, which though ever so well washed, yield a small quantity of acid on distillation. The same remark applies equally well to the pulvis algarothi. Mercurius dulcis retains its metal partly calcined and partly perfect *; and nitrated silver, in like manner can take up a portion of silver, without dephlogisticating it. Muriated copper, deficient in its acid, constitutes a peculiar salt hitherto undiscussed.

§ CXXVII. *Triple metallic Salts.*

WE have long been acquainted with a considerable number of metallic triple salts, that are not separable but by decomposition. Of this description are the combinations of tartar with iron and antimony; of the vitriolated vegetable

* Scheele in Actis Stockh.

getable alkali with iron; of the muriated vegetable alkali with platinum; of the vitriolated volatile alkali with copper; of the muriated volatile alkali with platinum, quicksilver, copper, and iron; of vitriolated and acetated quicksilver with iron; of vitriolated iron with magnesium, with copper, and with zinc.

§ CXXVIII. *Quadruple metallic Salts.*

THE quadruple metallic salts are formed by the union of sal ammoniac with nitrated iron, with nitrated copper, and with boracic quicksilver; of the vitriol of iron, likewise, with the vitriols of copper and zinc together.

§ CXXIX. *Alkaline metallic Salts.*

MOST of the alkalis also combine readily with metals, especially the volatile alkali; which sometimes forms beautiful crystals, with a metallic base, as with silver and copper. The numerous family of these salts are deserving of much greater attention than has ever yet been paid to them.

§ CXXX. *Synopsis of Salts.*

FROM what has been said, I am of opinion there can be no doubt of the extensive influence
and

and variety of the class of salts, in which we have here considered all those prepared by art, as well as those produced by nature. In favour of the halurgic system, I shall subjoin a table, presenting at one view all the chief varieties, with which I am acquainted. A greater number of proper experiments would certainly add many more to the account.

S A L T S.

Properly so called	{	Simple	{ Acid Alkali.
		Double	{ Neutral Imperfect.
		Triple	{ Neutral Imperfect.
		Quadruple	{ Neutral Imperfect.

Ana- logic	{	earthy	{	with an acid	{ double } { Perfect triple } { Imperfect
				with an alkali	double
		metallic	{	with an acid	{ double } { Imperf. with triple } { excess of acid quadruple } { Imperf. by defect of acid.
				with an alkali	double

§ cxxxi. *Species of Earths of a double Character.*

In the class of earths different species frequently occur, possessing two characters. To the first belong the saline earths; which, on account of the limits before assigned to them, are not reckoned in the class of salts, although they resemble them in their nature, and constitute but an imperfect species of earths. Of these substances, however, a few only are known, § 51.

§ cxxxii. *Mixed Species of Earths.*

GENUINE species of mixed earths are produced by the intimate union of two or more. Of the existence of such an union we have clear evidence, in § 90.

§ cxxxiii. *On what Arguments their Diversity is founded.*

Not the quality and number only of the ingredients, but even their relative weights imply a specific diversity.

§ cxxxiv. *The Necessity of considering the Proportion of every Part.*

IN the *Sciagraphia Regni Mineralis*, lately published

published, I have overlooked the mutual proportions; but, on further reflection, I find the consideration of them absolutely necessary.

§ CXXXV. *Method of investigating the several Species of Earths.*

IN order to determine with accuracy the species of earths, which hitherto seem to have rested on no very certain foundation, it will be requisite to explain carefully this doctrine. Let the five primitive earths be indicated by five initial letters, the ponderous by *p*, calcareous by *c*, magnesian by *m*, argillaceous by *a*, and filiceous by *s*.

§ CXXXVI. *Continuation.*

AT first we will attend to the character only and number of principles; and, by means of the doctrine of combinations, it will be easy to ascertain how many specific consociations can arise from these five letters.

For example, *p*, *c*, *m*, *a*, and *s*, can produce no more than ten double species—

pc, pm, pa, ps,
cm, ca, cs,
ma, ms,
as.

Of

Of triple species we have as follows :—

pcm, *pca*, *pcs*, *pma*, *pms*, *pas*,
cma, *cms*, *cas*,
mas.

Quadruple :—

pcma, *pcms*, *pcas*, *pmas*.

Lastly, One quintuple only :—

pcmas.

In this manner, from the whole class of earths, besides the five simple species, containing the primitives alone, we can obtain but twenty-six different combinations; which, together with the five simple, amount in all to thirty-one.

§ cxxxvii. *Why this Method is imperfect.*

In this plan, however, the number of the species is too much limited, and our conclusions liable to error. It will easily appear that *pa*, for example, must be separated; for the character of the mass, with an excess of ponderous earth, will be by no means the same as with an excess of clay. In like manner *pac* should be referred to three distinct genera, according as the first, the second, or the third principle bear the greatest share in the composition, (§ 78.). The same,
indeed

indeed, will be observed in whatever formula is employed. Therefore it is necessary, together with the number of the principles, to consider the weight of each.

§ CXXXVIII. *In what Manner can this Defect be supplied or corrected.*

THAT they may be all symbolically designed, and rendered obvious to the senses, a certain local value must be assigned to every letter; so that whatever principle occurs first in combination, that should be understood to be the heaviest of the whole mass: Every intermediate principle will yield to the preceding one, but exceed those that follow it, and the last of all will be of the least importance.

§ CXXXIX. *Enumeration of double Species.*

ACCORDING to this system then we shall have twenty double species :

<i>pc,</i>	<i>pm,</i>	<i>pa,</i>	<i>ps.</i>
<i>cp,</i>	<i>cm,</i>	<i>ca,</i>	<i>cs.</i>
<i>mp,</i>	<i>mc,</i>	<i>ma,</i>	<i>ms.</i>
<i>ap,</i>	<i>ac,</i>	<i>am,</i>	<i>as.</i>
<i>sp,</i>	<i>sc,</i>	<i>sm,</i>	<i>sa.</i>

§ CXL.

§ CXL. *Enumeration of triple Species.*

EACH of the five letters in forming triple compositions, may be arranged in twelve different ways. Five multiplied by twelve, therefore produce sixty species as follows :

pcm, pca, pcf, pma, pmf, pmc, pas, pac, pam,
pfc, pfm, psa.
cpm, cpa, cpf, cmp, cma, cmf, cap, cam, caf,
csp, csm, csa.
mpc, mpa, mpf, mcp, mca, mcf, map, mac, maf,
mfp, mfc, msa.
apc, apm, apf, acp, acm, acf, amp, amc, amf,
asp, asc, asm.
spc, spm, spa, scp, scm, sca, smf, smc, sma,
sap, sac, sam.

§ CXLI. *Quadruple Species.*

As the double species amount to twenty; and these, with the remaining three letters can be combined in six different ways, in the quadruple species, it will be easily seen, that six times twenty, or one hundred and twenty, will express the amount of this division.

S

pcma,

*pcma, pcam, pcmf, pcsm, pcsa, pcas, pmac,
pmca, pmas, pmfa, pmcf, pmfc, pacm, pame,
pacf, pasc, pams, pasm, psem, psmc, psac,
psca, psum, psma.*

*cpma, cpam, cpmf, cpsm, cpas, cpsa, cmpa,
cmaph, cmph, cmfp, cmas, cmsa, capm, camp,
capf, casp, camf, casm, cspm, csmp, csfa,
csap, csma, csam.*

*mpca, mpac, mpas, mpfa, mpaf, mpfc mcpa,
mcap, mcpf, mcfp, mcas, mcfa, macp, mapc,
macf, mafc, uapf, uafp, mfp, mfp, mfp,
mfp, mfp, mfp.*

*apcm, apmc, apmf, apsm, apcf, apfc, acpm,
acmp, acmf, acsm, acpf, acfp, ampc, amcp,
ampf, amfp, amcf, amfc, aspc, ascp, aspm,
asmp, ascm, asmc.*

*spcm, spmc, spam, spma, spca, spac, scpm,
scmp, scam, scma, scpa, scap, smca, smac,
smpa, smap, smcp, smpc, sapc, sacp, sacm,
samc, samp, sapm.*

§ CXLII. Quintuple Species.

THE triple species being sixty in number,
(§ 140.) and each of these admitting of two
changes only with the other two letters, it fol-
lows

lows, that, under this head, we may reckon one hundred and twenty species.

pcmaf, pcmfa, pcamf, pcafm, pcfam, pcfma,
pmcfa, pmcaf, pmasc, pmacf, pmfca, pmfac,
pamfc, pamef, pafmc, pascm, pacfm, pacms,
pscma, pscam, psmca, psmac, psame, psacm.

cpmaf, cpmfa, cpa^mf, cpamf, cpfam, cpfma,
cmpaf, cm^pfa, cma^pf, cma^{sp}, cm^pfa, cm^paf,
cam^pf, cam^pf, cap^mf, capsm, cas^pm, cas^mp,
csm^pa, csm^ap, csp^ma, csp^am, csa^pm, csa^mp.

m^pcfa, m^pcaf, m^pacf, m^pasc, m^pfca, m^pfac,
mcpaf, mc^pfa, mca^pf, mca^{sp}, mc^pfa, mc^paf,
ma^pcf, ma^pfc, mac^pf, mac^{sp}, ma^{sp}c, ma^{sp}c,
m^{sp}ca, m^{sp}ac, m^{sc}a^p, m^{sc}a^p, m^{sc}a^pc, m^{sc}a^pc.

apcmf, apcfm, apmcf, apmfc, apscm, apsmc,
acpmf, acpsm, acm^pf, acm^{sp}, acs^pm, acs^mp,
am^pcf, am^pfc, amc^pf, amc^{sp}, am^{sp}c, am^{sp}c,
asp^{cm}, asp^{mc}, asc^{pm}, asc^{mp}, asm^{pc}, asm^{cp}.

spcma, spcam, spmca, spmac, spacm, spame,
scpma, scpam, scmpa, scma^p, scamp, sca^pm,
sm^pca, sm^pac, smc^pa, smc^ap, smac^p, sma^pc,
sap^{cm}, sap^{mc}, sac^{pm}, sac^{mp}, sam^{pc}, sam^{cp}.

§ CXLIII. *Amount of the Species.*

IF the primitive earths are five in number, then the preceding paragraphs exhibit the formulæ of all those species that can possibly arise from their various combination; and to which, adding the five simple earths, we shall find the amount to be thus, $5+20+60+120+120=325$, the amount of the whole.

§ CXLIV. *Further Explanation of the Formulæ.*

I HAVE so contrived these formulæ as to make it evident to what genus every combination is to be referred.—The first letter determines the character of that genus, *s* only excepted; as, though it exceeds in weight, yet its other qualities do not always prevail, (§ 89.)

If at any time the number of the primitive earths is diminished, whether by decomposing them into others more simple, or by discovering them to be of a metallic nature, yet the same formulæ may be preserved after making the necessary correction.

For example, Suppose *p* were referred to the third class, the quintuple formulæ, (§ 142.) would then become quadruple, that series being destroyed entirely where *p* begins, and from all the others would it be taken away. In this case,

we

we lose the whole of the first genus, and the same formulæ are repeated four times in each of the remaining genera, and constitute one species only; so that $2^4 = 6$ species is of each genus and $4 \times 6 = 24$ the number of all the quadruple species.

Let us take another example, and remove altogether *a*, the formulæ of that genus are immediately annihilated, and the eighteen in the three other genera are reduced to $2 \times 3 = 6$.

In the same manner, that the corrections are made in the formulæ of the last order, can they be applied to those preceding. For it is evident that in reducing quadruple to triple species, it is impossible when *p* is destroyed, that the remaining series should be quadruple, and are therefore to be removed entirely.

Let *n* represent the number of primitive earths, and the number of the double species be expressed by *n*. *n*—1. of triple species by *n*. *n*—1. *n*—2, of quadruple species by *n*. *n*—1. *n*—2. *n*—3, and that of the last order by *n*. *n*—1. *n*—2. — *n*—*n*—2.

§ CXLV. *Species of Metals.*

HAVING determined these points, we now proceed to the third class, in which, on account of the greater number of genera, we shall find the species also to be far more numerous.

S 3

Metals

Metals occur generally either complete, mineralized, or deprived of their phlogiston.

§ CXLVI. *Native Metals.*

WHATEVER possesses a complete metallic form, is denominated native.

Into this state no heterogeneous substances are admitted, unless they are perfectly metallic. Hence arise various species;—the metal native and simple;—combined with some other;—or with several together. Native simple metals are very rare, and, as far as I know, have never yet been discovered perfectly pure.

Most metals are occasionally found native, as gold, platinum, silver, quick-silver, copper, bismuth, niccolum, arsenic, cobalt, and antimony; but scarce any one of them occurs quite pure. Gold is mixed with silver or copper; silver with gold or copper; platinum with iron; niccolum and cobalt with arsenic as well as iron; antimony with iron or zinc; and further experiments will without doubt discover other combinations.

The existence of native lead, iron tin, and zinc has been always much questioned by many.

Magnesium and siderite have never yet been found in a native state.

§ CXLVII. *Mineralised Metals.*

A MINERALISED metal appears to me to be a metal intimately united with some foreign substance that destroys more or less the genuine metallic form.

§ CXLVIII. *Mineralising Substances*

SUCH are fulphur and acids.

CXLIX. *Metals mineralised by Sulphur.*

SULPHUR can be directly united with all the metals, except gold, platinum, and zinc; and these mineralisations are found in the bowels of the earth. Sulphurated tin also occurs in Siberia *.

Some mineralizations are affected, both as to character and appearance, according to the quantity of sulphur. Tin, combined with twenty hundred parts of sulphur, forms a mineralisation, white and fibrous; but, with twice that proportion, the compound is micaceous, and of the colour of gold.

Sulphur acting on perfect metals separates a portion of their phlogiston; and is even capable of uniting with many calces likewise.

S 4

The

* Essays, vol. iii. p. 158.

The combination of gold with sulphur, by the intermedium of iron; is not yet made sufficiently evident; for that which is found in pyrites seems to be rather mixed than dissolved; as in a solution of pyrites, in the nitrous acid, the gold is deposited in molecules, not in powder, but differing from each other both in size and figure*.

As to zinc, that metal appears in the pseudo galena to be joined† with sulphur by means of iron.

§ CL. *Mineralising Acids.*

Of mineralising acids there are several, as the vitriolic, muriatic, phosphoric, aerial, and probably the arsenical.

§ CLI. *Vitriols.*

VITRIOLS of copper, iron, and zinc, are the spontaneous productions of nature. Combinations of the same acid with lead, niccolum, and cobalt, are likewise sometimes found; and they seem generally to be the result of decomposed mineralisations.

§ CLII.

* *Essays*, vol. ii. p. 412.

† *Ibid.* p. 329, and 336.

§ CLII. *Metals mineralised by the Muriatic Acid.*

THE muriatic acid is more rarely found united with metals. As yet it has not been discovered in any other than silver, quicksilver, and copper. The two first contain with it the vitriolic acid likewise *.

§ CLIII. *Metals mineralised by the Aerial Acid.*

THE aerial acid is often present in calciform metals. We meet with it in lead, copper, iron, and zinc. Of its connexion with other metals we have no certain intelligence.

§ CLIV. *Metals mineralised by the Phosphoric Acid.*

OF all the acids, that of phosphorus is the scarcest, and has hitherto been found with a spateous kind of lead only.

§ CLV. *Metals mineralised by the Arsenical Acid.*

THE arsenical acid, if I mistake not, is the true menstruum of the red cobalt, that is sometimes beautifully crystallised. It is certain, that a red colour is owing to an acid, and that, from all the experiments as yet made, no other has been discovered.

§ CLVI.

* Woulfe, Philos. Trans.

§ CLVI. *The different Species of Metals admit of almost numberless Variations.*

WHOEVER considers, that we are acquainted already with sixteen metals, and that of these the greater number of the perfect can be in several ways combined together, as well as those mineralised by sulphur and various acids, will naturally expect that, by means of accurate analyses, many more species might be discovered, which have as yet probably escaped the researches of the laborious philosopher. Were we to pursue the plan applied to the earths, (§ cxliii.) the number would be really astonishing; but I am almost of Pliny's opinion, who somewhere confesses: " Mihi contuenti sese persuasit rerum natura nihil incredibile existimare de ea." Formulæ, indeed, point out to us what may be done; but whether, and where, they are employed, must be learned from a faithful analysis; which assists us, besides, better to understand those of them that prescribe the true limits to our investigations.

§ CLVII. *Species of Phlogistic Substances.*

THE fourth class is exceedingly poor both in genera and species.

§ CLVIII.

§ CLVIII. *Species of the Diamond.*

WE are acquainted with many differences of the diamond, but with none that are specific.

§ CLIX. *Species of Sulphur.*

THE species of sulphur are distinguished by the diversity of their acids, and we know of two only; the common formed by the vitriolic acid, and plumbago, containing the aerial acid saturated with phlogiston.

§ CLX. *Species of Petroleum.*

THE varieties of petroleum, in colour and tenuity, depend for the most part on the degree of exsiccation, and on the matrix or heterogeneous substances mechanically mixed with it; so that they can be considered but seldom as specific. Exsiccation produces a mass thick and tough, or solid and dry.

§ CLXI. *Amber.*

THE same observations nearly will apply to amber. In respect of transparency and colour, we meet with many varieties in the European species.

The

The Indian species agrees in all thing with the European, except its being softer, and wanting the volatile salt*, which last circumstance seems to establish a specific difference. Copal, commonly so called, is to be distinguished from the gum resin of that name sold by the apothecaries.

§ CLXII. *Origin of Phlogistic Substances.*

DIFFERENT opinions are maintained by philosophers, respecting the origin of phlogistic substances. Some contend, that these bodies are proper to the fossil kingdom; while others, probably with more reason, ascribe them to those organic substances which abound in various oily and fat juices, and are not so much affected by time, as they are gradually changed in the bowels of the earth by neighbouring pyrites and other fossils, until they acquire a bituminous quality. Heterogeneous substances enclosed within them are evident proofs of original fluidity. The different degrees of purity of naphtha, coagulation performed by time, acids, or other media, and various circumstances besides in the great laboratory of nature, all influence the density, colour, clearness and other properties.

As to ambergrise, Aublet insists, that it is the juice of a tree growing in Guiana, and there called

* Lehman, Chem. Schrift.

called Cuina. He says, that after heavy rains, large masses of it are washed into the rivers. The specimens examined by Rosselle are said to resemble ambergris in their odor and principle qualities *. Long ago, Rumphius makes mention of a tree called nanarius, containing a juice similar to ambergris. Lately, however, in England an opinion has obtained, that this substance is the excrement of a cetaceous fish. Observations made on the physeter macrocephalus, (the spermaceti whale) have given rise to this Idea, as the excrement in the intestines of that animal, is found on dissection perfectly hardened, and containing the beak of the repia octopodia, on which it feeds, and in every respect resembling the ambergris of commerce.

§ CLXIII. *Species of Fossils mixed mechanically.*

Of fossils mechanically mixed, that fall under consideration in the first appendix, we have constituted four genera only, (§ 91.) their species, however, are numerous.

§ CLXIV. *The several Species expressed by the Formulæ of Letters.*

LET *s* denote salt, *t* earth, *m* metals, and *i* phlogistic substances; and let the same local value

* Hist. des plantes de la Guyane, 1774.

value be assigned to these letters as in the foregoing examples, (§ 138.) and we shall obtain the following double species.

st, sm, si.

ts, tm, ti,

ms, mt, mi.

is, it, im.

Triple species.

stm, sti, smt, sit, smi, sim,

tsm, tsi, tms, tis, tmi, tim,

mst, msi, mts, mis, mti, mit,

ism, ist, ims, its, itm, imt.

Quadruple species.

stmi, stim, smti, smit, sitm, simt,

tsmi, tsim, tmsi, tmis, tims, tism,

msti, msit, mtis, mtsi, mits, mist,

istm, ismt, itsm, itms, imst, imts.

§ CLXV. Continuation.

WE are, however, not rashly to conclude that all the species are exhausted in these formulæ; for every letter may be varied in many ways, according to the diversity of the several species. For example, *t* can be multiplied more than 325 times, (§ 131, 143). *I*, indeed, presents
but

but few variations, and *s* likewise; as the number of the salts proper for these mixtures, is exceedingly limited; but *t* surpasses even *m*, (§ 156); so that we have here another occasion of admiring the exhaustible stores of nature.

§ CLXVI. *The Position and situation of mixed Fossils.*

It is by no means to be expected; that every species of these mixed fossils, which to me appear to be *petræ*, should be equal to the production of huge mountains. The greatest number of them have hitherto been found in veins or small strata only; many of which, though of different characters, when combined, give birth to rocks. The same may be said of the separate particles, which, in the aggregate, form large and continued ridges of hills. But these almost always spring from the ruins and decompositions of mountains.

§ CLXVII. *Species of organic Fossils.*

ORGANIC fossils constitute four genera, (§ 97.); but the several species of fossils, whether possessing an organic form only, or with it an organic structure, are distinguished by specific marks.

§ CLXVIII.

§ CLXVIII. *Species of organic Fossils mineralised by Salts.*

ORGANIC fossils, penetrated with saline matter, are but seldom found. Gypsum, indeed, sometimes contains the less perishable remains of animals and vegetables; but these substances are scarce ever found quite gypseous. Entire animals are occasionally to be met, filled with vitriol, (§ 99.) and still oftener the harder parts of vegetables, or their roots, seem to resist putrefaction by the means of this salt.

§ CLXIX. *Earths.*

THE second genus, comprehending earthy fossils, is by far the richest. Innumerable calcareous nuclei of shell fish and marine insects daily occur in calcareous strata. Sometimes, an animal covering, or shell, which was before calcareous, being changed in its internal texture only, become spataceous.

Argillaceous nuclei of marine animals are common in aluminous schistus, but very rare in any other bed. Frequently the covering of the animalcule still remains.

Marine exuviae are obvious in marle also. If lime predominates, often the skeletons alone of the fish are seen. Of Osteocolla we have already spoken sufficiently, § 105.

Siliceous

Siliceous nuclei frequently fill entirely the internal cavity of organic fossils, and sometimes even the same matter surrounds their external surface. I am in possession of an *echinites*, the shell of which is filled with common flint, and shews upon the surface of the nucleus all its natural inequalities; the shell itself, however is calcareous and spateous, although it was imbedded in siliceous earth on both sides. Small shells occur sometimes in jasper, but very rarely*, and are not more frequent in petrosilex.

Organic bodies, themselves also are found penetrated with siliceous matter. Siliceous petrifications of the trunks of trees are often distinctly marked with the growth of every year. Siliceous muscles and cockles also frequently occur, and small corals even are sometimes clearly to be distinguished in common flints.

I have seen the marks of leaves accurately expressed in quartz, and the epitomium of Blankenburg is often quartzose.

Nuclei of sand are sometimes to be met with; but the figure of their surface is generally so obscure, that it is very difficult to determine from what organic body they were produced.

In the sand pit at Maestricht was found not long ago the skeleton of a crocodile, some teeth of which were sent to me.

T

§ CLXX.

* Ferber in Epist. de Italia,

§ CLXX. *Species of organic Fossils impregnated
with metallic Particles.*

VERY few metals assume an organic form. The calx of iron, but slightly cohering, or con-
creted like a stone, penetrates roots, wood, and
even whole trees, preserving still the fibrous
texture, which may sometimes be scraped with
the nail.

Pyrotaceous iron, indeed, now and then forms
nuclei; but it commonly adorns the organic
structure with lines or little spots, and seldom
occupies it entirely.

Copper, in the form of a calx is supposed fre-
quently to enter into bones and teeth, giving
them a blue colour, especially after they are
calcined. This colour, however, is often ow-
ing to iron.

Pyritaceous copper also resembles the anomia
in the magnet of Iarlsberg in Norway, and fishes
in several places.

Spots of native gold or silver are sometimes
seen on the surface of fossil shells.

The grey ore of silver at Frankenthal in Hesse
is found in the form of ears of corn, and com-
monly called *kobrn-abren*; and under the ap-
pearance of leaves and stalks of some granife-
rous vegetable.

Cinnabarine shells are exceedingly rare.

I have in my possession some pseudogalena of a blackish yellow, united to millepores.

§ CLXXI. *Species of Phlogificated organic Fossils.*

Wood impregnated with petroleum frequently occurs. There is a trunk of a tree in the collection of the academy at Upsal, indurated with petroleum, black and smooth, and yet easily distinguished to be of a beech. The Icelandic fossil wood also comes under this head, of which I have spoken more fully in another place*.

Bones penetrated with asphaltus are sometimes found.

As is fossil wood likewise, whose pores are filled with amber, and even with insects and other small animals; which this substance does not only penetrate, but even surrounds, as a splendid monument covering their remains.

Turf and mould contain organic bodies, especially of vegetables reduced in the greatest part by putrefaction to dust; but which display signs of their original structure and character, more or less obscure. The first scarce differs from the latter but in the greater decomposition and density of its mass.

* Essays, v. iii. p. 239

V A R I E T I E S.

§ CLXXII. *Ordinary Confusion of Varieties with Species.*

THAT many varieties have been observed in species properly determined is the more evident, as they have, for the most part, been considered as different species. A mistake to which the practice of the mineralogists in determining specific differences from external marks undoubtedly gave rise.

§ CLXXIII. *Criteria of Varieties to be taken from external Appearances.*

IN the foregoing, we have shewn that specific marks were to be taken from the particular composition ; but although superficial criteria do not affect the intimate nature of these bodies, yet they are not by any means to be neglected ; they are well calculated to determine varieties, and are even useful, not only in leading often a skillful eye to proper diacritic experiments, but in throwing light upon the mode of production, and other interesting circumstances.

§ CLXXIV.

§ CLXXIV. *Illustration of external Marks.*

THE chief external marks are those taken from the form of the outward surface; the texture, in the appearance of its particles by a recent fracture; the colour, hardness, and gravity.

§ CLXXV. *Amorphous Fossils.*

FOSSILS that have no determined shape are denominated amorphous.

§. CLXXVI. *Crystalline Fossils.*

BUT those whose circumference is included within plain sides meeting each other at various angles are called crystalline.

In the fossil kingdom, we have five regular geometric figures, of plain, equal, and similar sides; as the tetraedra, cubes, octaedra, dodecaedra, and icosaedra; besides many others distinguished by their prismatic columns and pyramidal terminations. In what manner the great number of derivatives arise from a few primitives, and differing from each other at the first view, I have related elsewhere*.

Salts, indeed, on account of their solubility

T 3

in

* Essays, vol. ii. p. 1.

in water, more readily acquire a subtilty and freedom of their particles, which, through the means of attraction, is necessary to form them into crystalline concretions; but this property is not limited to them, as crystalline fossils are found in almost every genus of earths, metallic, and phlogistic substances.

§ CLXXVII. *External Marks taken from the Texture of Fossils.*

THE texture of fossils is not easily determined by the form of the particles; as when they are intimately combined with each other they are always mutilated by fractures; we may, however, distinguish many varieties. The most subtile; shapeless molecules usually called impalpable, give rise to an equal texture: while others larger, and more discernable produce a granous, filamentous, scaly, and spataceous composition.

§ CLXXVIII. *From the Colour.*

COLOURS, especially the gradual shades of them, can scarce be so described by language, as to convey any clear idea, Hardly any other method, therefore, than that of comparison can be used by always referring to those colours sufficiently understood.

§ CLXXIX.

§ CLXXIX. *Physical Marks.*

PHYSICAL marks also, as hardness and gravity, are to be employed for ascertaining varieties, whenever they are found to throw any light.

§ CLXXX. *Varieties of organic Fossils.*

THE varieties of organic fossils are to be determined from the species of vegetables or animals, which serve as guides to our judgement. And all living bodies being defined by their external appearance, the same rule may be observed in this as in the other classes.

§ CLXXXI. *Epilogue.*

A SYSTEM of fossils, arranged according to the foregoing method, I think is to be recommended for its variety, order, and utility; for the number of species and varieties, the manyfold combinations of principles, the series of agreement and discrepancy, the harmony and opposition of internal and external characters, and many other important reasons: And I hope it will be found to answer better, not only on account of its extensive view, but also because the riches and phenomena of the organic kingdoms are in it more properly displayed than in any other.

LATTER PART.

OF GIVING NAMES TO FOSSILS.

§ CLXXXII. *The Utility of Names properly adapted in Mineralogy.*

IF fossils are rightly and justly arranged and denominated, agreeably to the nature of things, we find a harmony in them not less grateful than advantageous.

§ CLXXXIII. *History of Names in Natural Philosophy.*

THE sciences cultivated during the early ages, as chemistry, and all those depending on it, had unhappily adopted certain schemes and modes of speech, of which the greater part were not only puerile and absurd, but often altogether false, and leading to erroneous conclusions. Many circumstances contributed to the support of this mummary. At first, in those days of darkest ignorance, names were required to describe new discoveries and phenomena, adapted to the unskilfulness of their authors. By degrees the knowledge of natural bodies, as well as of artificial, being extended, the professors of chemistry began to entertain such lofty ideas of
their

their skill, that they did not hesitate to promise themselves the miracles of an universal medicine, and the making of gold. Hence arose the ridiculous struggle betwixt the immoderate boastings, through which they were endeavouring to dispose advantageously of their discoveries, and the most solicitous attention with which they wished to keep them concealed. What the names they employed could be, when depending on the most absurd theories, the slightest appearances, and most abstruse metaphors, we are at no loss to apprehend. To these were added afterwards others produced by any fortuitous slight occurrence; and we perceive in some measure a language peculiar to the early operations of chemistry.

§ CLXXXIV. *Of reforming the Names of Fossils.*

THE institution of academies of science gave rise to the gradual introduction of a sounder theory, founded upon more accurate experiment, which tended considerably to limit the barbarous and mystical affectation of secrets; and occasioned a more rational denomination of new discoveries, though as yet not built upon general principles. Besides, the rude and indigested mass of antiquity was still preserved for the greatest part, and chiefly for the following reasons. From the reformation of names and
phrases

phrases, it was apprehended that the whole science would be involved in great confusion, and that their number would create considerable difficulties; and it was likewise alledged, that the most ancient writings would, by this means, be rendered unintelligible, and all the science they contained condemned to oblivion. But such evils, at least not all of them, seem not to be a necessary consequence. The oldest writings, especially those on alchemy, are almost all of them incomprehensible: Whatever therefore will answer to probable conjecture, or will admit of a certain and determinate explication, might be more easily understood, if transposed according to the nature of the subject,—and the sense of this or that denomination being once extracted, it might be preserved in a book appropriated to the purpose. As to what relates to the dread of the introduction of new names, it would undoubtedly be well grounded were not all writers to suffer them to be regulated in the same manner. In this case the new names adapted to the nature of things would readily insinuate themselves, and be universally received.

Surely, it is highly improper that the noblest science, which constitutes, as it were, the very essence of natural philosophy, should deliver truths of the greatest importance in the most absurd of all languages. Every country in Europe

rope has thought the cultivation and perfection of its peculiar language an object highly worthy of attention; and shall the sciences alone be distinguished for rudeness and barbarity of stile, while they are daily requiring new names to express new discoveries constructed upon rational principles; and which, if they are not all wisely and methodically ordered, would sometimes by their number occasion the destruction of those very discoveries they were intended to preserve. In botany, such a reformation has long taken place; and what is there that should prevent so salutary a plan from being extended to the other sciences?

But notwithstanding the obvious necessity of reform, as well as of some fixed standard, according to which all the new names should be regulated, there are still many difficulties that oppose their free introduction into the republic of letters. From the very nature of the proposal it is exposed to the influence of particular opinions; and every one, partial to his own, and chusing different data, it will be impossible in the beginning at least, to unite, in one common consent, sentiments so adverse and contradictory. We are not however to despair; for, if the voices of all do not combine, perhaps the greater number will, to stifle the clamour of persisting cavillers. Every real friend to chemistry, therefore, should wish for a happy issue to
the

the plan of Mons. Morveau, to be attempted in the new Encyclopædia. In the mean time, it may be permitted me to offer a few cursory remarks, which I think are relating particularly to mineralogy, and submit them to the judgment of the public. The end of the whole system is doubtless to express with truth, perspicuity, precision, and brevity, every thing of which an idea can be conveyed by words. New names, therefore, become necessary to new things; and to render these the most convenient is the chief aim and object of this undertaking.

§ CLXXXV. *Names that are evidently absurd, and ought to be expunged.*

I AM of opinion, that all absurd names, and such as betray ostentatious vanity, are to be entirely set aside. Of these we have examples in the *fal mirabile Glauberi*, *fal secretum Glauberi*, *fal polychrestum Glaferi*, *arcanum corralinum*, *arcanum duplicatum*, *fal de duobus*, and several others.

§ CLXXXVI. *And false Names likewise.*

IN like manner, names that are false ought to be removed. Of this description are the following, suggesting ideas that are erroneous:

Oleum

Oleum vitrioli	} For }	Concentrated vitriolic acid.
Spiritus vitrioli		Diluted vitriolic acid. Spirit indicates properly an inflammable liquor miscible with water.
Oleum tartari		Vegetable alkali dissolved by deliquescence.
Sal tartari		Alkali of tartar.
Terra foliata tartari		Acetous acid saturated with the vegetable alkali.
Butyrum antimonii		Muriatic acid saturated with antimony.
Semi-metallum		Fragile metal.

§ CLXXXVII. *What then are the names to be adopted?*

THOSE names which indicate some essential property or composition are of all others the best.

§ CLXXXVIII. *What are the Names to be tolerated?*

THOSE which admit a more extensive signification may be suffered, if others evidently better cannot be substituted. And these indeed
are

are true names; for although, from the power of the words, they will apply to many substances, nothing prevents them from being *κατ' εἶδος* applied to the one or the other. In this way acidum aerium was used in the year 1772, for aer fixum; which is not absolutely advancing a falsehood, as it possesses a proper acid, and in an aerial form; but it is objectionable, because these qualities are discoverable in other substances. Let therefore some other denomination be substituted more exact and determinate, as, gas, or acidum mephiticum, or else there will be no end to the various changes. But if it be impossible to find one more accurate, it will be attended but with little inconvenience, to apply it to that substance which we know for certain to be the acidum aerium of the antients.

§ CLXXXIX. *Names signifying less than the Thing defined ought to be abolished.*

WHATEVER names express too limited a sense should certainly be expunged, if a choice can be made among those that are synonymous, especially those recommended by long time; as they convey false and inadequate ideas. Thus *mineral* indicates properly an ore; but in the vulgar sense it signifies every inorganic body found in the bosom of the earth; although this idea is more accurately expressed by the word *fossil*.
In

In like manner, *oryctologia* implies a more exact denomination of the science of fossils than *mineralogia*. *Petrefactum* or *petrificatum*, falls nearly under the same criticism. But as here we have no better synonymous word to substitute, we must be contented with such as custom has established. Words, like coin, owe their currency to prescription.

§ cxc. *How we are to proceed without proper emphatic Names.*

As it is not easy to apply names exactly expressive of the thing defined, we are to adopt such as having no determinate meaning may have their sense ascertained by definition.

§ cxci. *Names derived from the Authors of new Discoveries.*

AMONG botanists and anatomists the memory of discoverers is perpetuated in particular denominations; it may, therefore, be a question, whether among chemists, where the reward of new facts is attended with greater inconvenience, it would be proper in the same manner to testify a grateful sense of obligation? To me, indeed, it seems to be practicable, and without any impropriety; but as it often happens, that the same discovery has been made by different individuals

individuals at the same time, it might, upon the whole, be better to trust the fame of all, to the impartial records of the historic page. This exception, however, need not extend to names of little importance in chemistry.

§ CXCII. *By what Means are the Classes of Fossils to be defined?*

EACH class of fossils should, if possible, be defined by one single word. Such as,—Salts, Earths, Metals, and Phlogistica. True, indeed, the last is an adjective; but on this account solely it is not to be rejected, as we shall presently shew: Nor, indeed, have we reason to apprehend ambiguity from the use of it, as the context will always determine whenever it refers to fossils. If any one should think the word *bitumina* preferable, I can have no objections; although it may appear extraordinary to many to consider diamonds under this definition.

For want of a more proper appellation, I distinguish fossils mixed mechanically under the name of *Petræ*. My reasons for this distinction I have given already in § 166. Those, however, that form the subject of the other appendix, as organic fossils, can scarce be defined under one title, and we must therefore either employ two, or call them in general *Petrefactions*, § 189.

§ CXCIII.

§ CXCI. *Denomination of Genera.*

EACH genus should be expressed in one word, for the sake of brevity and convenience.

Among the salts there are, strictly speaking, but two genera; the acid and the alkali. And we shall see by and bye the great advantage this produces, that the combinations of every acid constitute proper genera. An acid may be considered substantively without the necessity of having the word Salt prefixed to it, as every acid is a salt.

In the second class we have found five genera. One of which, but lately discovered, has, on account of its specific gravity, obtained the name of Terra Ponderosa. But in order to render it more concise and convenient, the first word might be easily omitted, though always understood, and the last employed alone as a substantive; or we would, with Mons. de Morveau, adopt Barites from *βαρύς* with great advantage. The remaining earths are all expressed with substantive names; but for the sake of perspicuity, I would yet recommend some alteration in them: As for example, Calx, Magnesia, Argilla, and Silex, are descriptive of fossils, such as they occur on the surface of the earth, blended more or less with heterogeneous matter; and therefore the words Calcareum, Magnesium,

U

Argillaceum,

Argillaceum and Siliceum, might be properly used to signify these substances pure and unmixed.

The names of the sixteen metals are all substantives, and except one, are of the neuter gender. The *υδραργυρος* of the Greeks was translated into Latin by Pliny *hydrargyrum*, and why may not the *platina* of the Spaniards be adopted into the same language, with a neutral termination? According to this proposal, we shall have the following generic names, *aurum*, *platinum*, *argentum*, *hydrargyrum*, *plumbum*, *cuprum*, *ferrum*, *stannum*, *vismutum*, *niccolum*, *arsenicum*, *cobaltum*, *zincum*, *antimonium*, *magnesium*, and *fiderum*, if this last differs at all from iron. Each of them are to indicate the metal in its complete state. Dephlogisticated metals, commonly called calcined, or metallic calces, resemble indeed, in some measure, burned chalk, from their attraction of the aerial acid, from their becoming caustic with the volatile alkali, their susceptibility of pulverisation, and other properties.

Of phlogistic bodies, the generic names are so well constructed that we have no remarks to offer upon them: *Adamas*, *sulphur*, *petroleum*, and *succinum*, are received with propriety.

The four genera of *petræ* I define by the following names. The first, abounding in saline matter, I call *salsamentum*; the second, loaded with earthy matter, appears to me to be properly

ly

ly *saxum*; the third, containing metals in their matrices, I denominate *minera*; and the fourth, from the mixture of petroleum, or other phlogistic bodies more plentifully found in it, takes the name of *bitumen*; or, if this name be given to a class, *picarium* may be substituted.

Of the organic fossils, that which is penetrated with any salt may be called *salitura*; with earthy particles, *lapidosum*; with metallic, *metalliferum*; and with phlogistic, *pollinctum*. Should names more proper than these occur to any person I shall have no objection to withdraw them.

§ cxciv. *Of applying Names to the simpler Fossils, and especially to the Salts.*

ALL bodies, whose proximate principles have never yet been ascertained by art, require simpler names; the primitives especially should be expressed by one word; and those of a known composition should be defined by derivatives having a reference to their principles; if not of one or two words, consisting at the most of three. To denote each body by a peculiar simple name would be productive of great inconvenience, and be an useless burden to the memory. It might however be of considerable advantage to the system of nomenclature, in the class of salts, if every one of the simple salts could be indicated by a single word. Would it

not therefore be admissible, by supposing the acid to construct the names as substantives? As for example, *vitriolicum*, *nitrosum*, *muriaticum*, *regalinum*, *fluoratum*, *arsenicale*, *boracinum*, *saccharinum*, *oxyalinum*, (inherent in the acid of the wood sorrel) *tartarum*, *benzoinum*, *citrinum*, *succineum*, *galacticum*, *formicale*, *sebaceum*, *phosphoreum*, and *aereum*. Phlogisticated vitriolic acid might be named *fulphureum*, and phlogisticated nitrous acid *nitreum*. In like manner, in the genus of alkalies, the vegetable will be *potassinum*; the mineral *natrum*, a name by which it has sometime been already known; and the volatile will be *ammoniacum*. The great advantage of this simplicity, as we shall see presently, will be obvious in giving names to compounded substances; which, if they consist of more than two or three words, will give rise to a diffuse and circuitous stile, both in speaking and writing. All names certainly proceeding from the definition of several words are by far the most improper.

§ cxcv. *Names of Species demonstrated in the Case of Salts.*

SPECIFIC differences, that can serve as distinct names, are used with considerable advantage. Admitting what has been already proposed in the preceding paragraph, this very easily

fly obtains in the class of salts, as to all the species perfectly saturated. That earthy and metallic salts ought to be arranged under the head of their menstrua, we have seen in § 70.; but, with respect to the perfect neutral salts, it is not so clear, § 68. It seems indeed more convenient to refer them to the genera of their several bases; and in this way also I have proceeded. But we shall have more agreement with the analogical salts, most of which are properly assigned to the acid, if the neutral salts are subjected to the same arrangement. According to this method we shall have names sufficiently apt by combining the acid with the adjective of the basis. As for example,

Vitriolicum potassinum,	for {	Tartarus vitriolatus.
Nitrosus natratus,	— {	Nitrum cubicum.
Muriaticum ammoniacum,	— {	Sal ammoniacus.
Acetum potassinum,	— {	Terra foliata tartari.
Vitriolicum calcareum,	— {	Gypsum.
———— magnesium,	— {	Sal catharticus amarus.
———— argillatum,	— {	Alumen.
Nitrosus barytatus,	— {	Barytes nitratus.
———— argillatum,	— {	Calcareum nitratum.
Muriaticum barytatum, &c.	— {	Barytes muriaticus.

Metallic double salts also may be treated in the same manner ; as,

Vitriolicum auratum, &c.

Nitrosum argentatum, &c.

Muriaticum plumbatum, &c.

Arsenicale cobaltatum, &c.

and many others.

No one can object to those adjectives derived from the names of the metals, as Pliny uses the word *ferratum* ; and it is according to this plan that they are here applied.

Analogical salts, containing an alkali, may be easily arranged in the same manner.

Thus,

Potassium	— {	Argillatum,
		Silicatum, &c.
Ammoniacum	— {	Argentatum.
		Cupratum,
		Zincatum, &c.

Double salts, in which either principle prevails can also be denominated in such a manner as to express an imperfect saturation, § 127. For example,—Tartar, with an excess of acid, can be defined by a combination of its generic name with the genitive of its base, as *tartareum potassini* ; but, when perfectly saturated, may be called *tartareum potassinatum*. In like manner we shall have *oxalinum potassini*, but, when exactly saturated, it will be *oxalinum potassinatum* ; *vitriolicum natri*, and *vitriolicum natratum* ; *natrium boracini*, and *boracinum natratum* ; and so on of others.

This

This method, however, is not applicable in other classes, not even to the double species. Saline earths, with such an excess of earthy matter as nearly to obliterate their saline character, ought thus to be expressed.

Barytes vitriolatus, for Spatum ponderosum.

Calcareum fluoratum, — Fluor mineralis.

Calcareum aeratum, — Calcareum vulgare.

The character of the remaining fossils differs more considerably from the salts, and requires auxiliary illustration.

§ cxcvi. *Trivial Names of Salts.*

FOSSILS, containing three or more principles appear capable of the clearest definition by means of the trivial names. The celebrated Linnæus first made use of such, in his Species Plantarum of 1753, by which every species could be conveniently expressed, without a repetition of the specific differences. The language of botany became thus remarkably easy and intelligible; and zoologists and mineralogists have to thank the same author for the happy introduction of them into their sciences.—But, although these names may be assumed from the inventor, some virtue, ancient appellation, property, or accidental circumstance respecting the species; yet should they be generally limited to one word, and very seldom indeed extend to two. They may be considered as surnames dis-

tinguishing the individuals contained in the same genus.

The triple salts are, by means of these trivial names, denominated with great facility. Of which we have the following examples :

Vitriolicum fallax	—	{	Epsom salt united to the volatile alkali; easily producing an apparent inequality of attract.
—— epilepticum,	—	{	Epileptic salt of Weifman.
Muriaticum anti-epilepticum,	—	{	Anti-epilepticum puerorum of Boerhaave.
—— alembrot,	—	{	Sal alembrot.
—— dulce,	—	{	Mercurius dulcis.
Galacticum Bartoleti,	—	{	Sugar of milk, first described by Bartoletus.
Tartarum Seignetti,	—	{	Sal polychrestum Seignetti.
—— Lafonii,	—	{	Tartar joined to the sedative salt.
—— solubile,	—	{	Tartar saturated with volatile alkali, — commonly called tartarus solubilis.
—— Mynfichti*,	—	{	Tartarus emeticus.
—— martiale	—	{	Globuli martiales.
Phosphorum microscmicum,	—	{	Sal microcosmicus.

Compound

* Essays, vol. i. p. 340.

Compound salts, produced by regalinum (*aqua regis*) never become triple, at least not all of them. The nitrous acid seems to be necessary for the purpose of dephlogistication only; and the muriatic generally exhibits the same combinations as the regaline, by which, if the muriatic is not in sufficient quantity, a double salt is obtained, charged with the nitrous acid,

The same observation is equally applicable to the quadruple salts.

Tartarum Fevri,	— { Tartar united to bo-
	rax,
Nitrosum Kunckelii,	— Rubini Kunckelii.
—— sympathicum,	— { Sal ammoniac with
	nitrated copper.

This salt exhibits crystals, that assume a yellow colour when heated, but become blue in a moderate temperature. If a solution of them sufficiently diluted is used for writing, the letters will be found to disappear entirely, by the application of heat; and, if exposed to the vapour of caustic volatile alkali, to change to a beautiful blue colour.

Thus, then, I have pointed out a method, as I apprehend, both easy and simple, by which all the known salts, about fifty in number, may be each denominated in one or at most in two words.—According to the first division, we have the genus only.—Of the second, the double salts completely saturated are indicated by the adjective of their base ending in *atus*. In the third, the imperfect salts are known by the
genitive

genitive of their base.—The fourth contains the triple salts and those of several principles, which are expressed by the trivial names; and as in them we neither find the adjective of the base *atus*, nor the genitive, it is not possible that any ambiguity can arise.—The whole composition of the triple salts could not be signified in two words, unless the double salts were defined in one only; and if the same brevity were expected of the quadruple, the triple must have necessarily been denominated by one. But it may be a question, whether it is more difficult to invent such a number of new and simple names, or, if invented, whether they could possibly be retained by the memory.

§ CXCVII. *Of the specific Names of Earths, Metals, and Phlogistic Substances.*

IF we consider every thing that has been said in the foregoing sections on the subject of the salts hitherto known and investigated, we shall find, that we have in some measure laid the foundation of a general system of mineralogy. With regard to the earths, and the following classes, the denomination of the double and more compounded species may be conveniently expressed by the trivial names in two words. Thus, for example, under the genus *magnesia*, a species occur, in the formula, *smca*, composed
of

of filiceous, calcareous, and argillaceous earth, with some admixture of iron *, which in systematic authors is denominated asbestos, and treated as a peculiar genus. To this, indeed, the trivial name of asbestos may be properly applied, as it seems to be so well understood, that the youngest mineralogist is in no danger of being misled by it. The same may be said of schoerl, granate, zeolite, and many others, that are distinguished by names known to every body, and highly proper. In the composition of earths, iron is by no means a necessary ingredient, although it is generally found in them; and we therefore consider it as an alloy, or heterogeneous substance.

§ CXCVIII. *Conclusion.*

I CANNOT finish my remarks on the denomination of fossils more to my own satisfaction, than by pointing out what is yet wanting to the improvement of science. I would wish that in the establishing of new names, a preference should be given to the Latin language. This is, or at least was formerly the mother tongue of the learned; and being now not the living language of any nation, it is no longer liable to innovation or change. If therefore, the reform we propose is made first in Latin; it may be easily
carried

* Dissertation on the asbestos.

carried into execution afterwards upon the same model in the modern languages, as far as their peculiar genius and construction will admit.—In this manner, the language of chemistry will become every where uniform and consistent, and considerable advantage will be derived not from the reading only of foreign publications, but the facility also with which they can be translated. I have seen an excellent essay of *Monf. de Morveau* on the reform of the French names*, and I am not a little flattered by the agreement I find between many of the alterations he proposes and those that I have offered on that subject. From this, perhaps, we may venture to hope, that by making it an object of further attention on both sides, the differences yet subsisting may be removed, to the great benefit of science; and to the permanent establishing and advancement of which all our views should be directed.

* *Diary of Monf. Rozier.*

